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Supplementary information

Similar scaling laws for earthquakes and Cascadia slow-slip events

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Sylvain Michel, Adriano Gualandi & Jean-Philippe Avouac

Similar Scaling Laws for Earthquakes and Cascadia Slow Slip Events

Supplementary document

Sylvain Michel[1,2,4], Adriano Gualandi[1,3], Jean-Philippe Avouac[1],

This document presents:
- an explanation on how Slow Slip Events (SSEs) duration and moment release measurements were estimated;
- a discussion on moment, duration and area estimation biases, and a comparison with SSEs from the literature;
- a comparison of tremors durations[10] and SSE durations from geodesy (this study);
- the source time functions of the SSEs analyzed in this study followed by explanations on how the onset and end times of each event were estimated.

Measurements of SSE duration and moment release

In our original study[15], we applied an equiripple low-pass filter to the slip deficit, $\delta_{deficit}$, with passband frequency of 1/21 days^{-1}, stopband of 1/35 days^{-1}, passband ripple of 1dB with 60dB of stopband attenuation. Calling $\dot{\delta}_{deficit}$ the slip rate deficit on the megathrust with respect to the long-term creep, SSEs are detected when $\dot{\delta}_{deficit}(p,t) < V_{thresh}$, where V_{thresh} corresponds to a slip deficit rate threshold set to -40 mm/yr. The applied filter removes any SSE with a duration under 3 weeks and bias the estimation of the start and end of moderate SSEs, thus their duration.

To attenuate the duration estimation bias of the SSEs detected by the method described above, we proceed as follows. For each SSE, we focus only in the area as defined by the previous filter. Starting from the first automatic detection [t'_{start}, t'_{end}], we consider an enlarged time span [t_{start}, t_{end}] = [t'_{start} – 35 days, t'_{end} + 35 days]. Instead of applying a low-pass filter, which truncates all events with frequency higher than the specified passband frequency, we perform a zero-phase digital filtering on the rough $\delta_{deficit}$ using a 5-day window. The filter is an averaging sliding window which passes through the data in the forward and reverse direction. As a result, the time shift is zero and periods shorter than 9 days are filtered out. We then convert $\delta_{deficit}$ into moment deficit, $M_{0deficit}$, taking a shear modulus $\mu = 30\ GPa$ and calculate the moment deficit rate, $\dot{M}_{0deficit}$, by taking the derivative in time. The derivative is taken using 1 day time steps. Note that, even by focusing directly on a specified SSE area, it is not possible to detect the onset and end of a SSE by looking at its global moment rate function obtained as the integral of the moment rate over all the selected sub-faults. Indeed, the onset of a SSE can be masked by neighbouring sub-faults with positive $\dot{M}_{0deficit}$ (associated with loading). It is thus important to look at sub-faults individually to detect the onset and end of a SSE.

The complex $\dot{M}_{0deficit}$ signal of each sub-fault makes it very difficult to establish an automated detection of the SSEs' time-boundaries, and we thus base ourselves on two manual methods to estimate the onset and end of SSEs, the two methods providing a minimum and maximum duration estimation. 1) The first method, which provides the minimum duration estimation, consists in a) taking a slip deficit rate threshold, V_{thresh}, set to -40 mm/yr, b) calculating for each sub-fault its equivalent moment rate, $\dot{M}_{0\,thresh}$, since the sub-faults have different areas, and c) determining the timing of the first and last sub-fault with $\dot{M}_0 < \dot{M}_{0\,thresh}$. This method is generally straight forward but provides a SSE duration underestimation since the event could well be continuing but with moment rates under $\dot{M}_{0\,thresh}$. In several cases the sub-faults moment rates present several peaks oscillating around $\dot{M}_{0\,thresh}$ (e.g., SSEs #33, supplementary document). In such cases we generally pick the duration on the most plausible peak related to the SSE (even if the other peaks might be part of the SSE) aiming in doing so to provide an absolute lower limit of the duration. 2) The second method, which provides the maximum duration estimation, is an estimation of the timing of the first and last subfault when $\dot{M}_0 < 0$. However, due to the noise in the slip time series, there is no simple way to determine this timing. We choose to consistently take the onsets and end of SSEs that determine their maximum duration possible regarding the data available, at the risk sometimes to add noise within the time-boundaries. The two described methods serve as guidelines and provide a bracket on SSEs' duration. An example of duration estimation is shown in Extended Data Fig. 2 for SSE 34. The SSEs estimated onset and end times are provided in Table S1 and shown in the supplementary document, which contains also the explanation of each events picking.

The bracket on SSEs' duration also provides a bracket on their moment release. The total moment release, M_o^{Total}, of a SSE is defined as:

$$M_o^{Total} = \sum_{p=1}^{Q} M_0^p(T_{end}) - \sum_{p=1}^{Q} M_0^p(T_{start}),$$

where Q is the total number of sub-faults involved in the SSE, $M_0^p(t)$ is the cumulative moment released by patch p at time t, and T_{start} and T_{end} are the SSE onset and end times as determined by the 2 methods mentioned above. An example of the procedure is shown for SSE 34 in Extended Data Fig. 2b.

Moment, duration and area biases, and comparison with SSEs from the literature.

Various sources of bias were present in the initial catalog[15]. Biases in the duration estimation due to automatic picking of the onset and end of each SSE and to the temporal filtering were alleviated with the manual picking method described above and by accounting for the filtering effect in the determination of the best fitting scaling law

(Methods). The duration estimations depend also on the initial slip rate detection threshold of SSEs[15] which determines the SSEs areas.

Biases on SSEs areas might originate from both the slip inversion regularization[15] and the SSEs slip rate detection threshold, V_{thresh} (see supplement *Measurements of SSE duration and moment release* and *Measurements of SSE rupture area and aspect ratio*). The detection threshold method tends to underestimate areas since sub-faults could well be part of a SSE but have slip rates under V_{thresh}. Lowering V_{thresh} would enlarge the rupture areas and increase the noise level. Note that the detection threshold bias is also dependent on the temporal filter applied on the initial slip deficit for the SSEs detection[15] (filter with a passband frequency of 1/21 days^{-1}, stopband of 1/35 days^{-1}, passband ripple of 1dB with 60dB of stopband attenuation).

Moment estimation biases are also linked to the biases mentioned above since they are estimated based on the SSEs onset and end time (see supplement *Measurements of SSE duration and moment release*), and depend on the SSEs area estimation too.

There are three common events in the SSE catalogs of Michel et al.[15] and Schmidt and Gao[27]. These three events have similar magnitudes and similar distributions (Extended Data Fig. 4). The peak slip estimated by Michel et al.[15] are half those of Schmidt and Gao[27] though. This is probably because the solutions of Michel et al.[15] are more strongly regularized (resulting in smoother slip distributions) and do not include inter-SSE-loading. The slip potencies (the integral of slip over rupture area) agree within 30% between the two studies. Note also that Michel et al.[15] uses an elastic modulus of 30GPa instead of 50GPa in Schmidt and Gao[27], and that the SSE areas are determined differently in the two studies.

Comparison of tremors durations[10] and SSE durations from geodesy (this study).

We compared the SSEs duration that we measured based on the GNSS times series with the duration derived from the tremors[10]. We used revised time picks of the onset and end of the tremors provided by Gomberg (personal communication). For these common events the durations derived from the tremors and from geodesy are consistent given the effect of the filtering (Fig. S1). To further test the robustness of our conclusion, we used the timing of the tremor bursts estimated by Gomberg and calculated the associated moment release using our slip model for each common SSE. In that case the durations are not affected by any filtering effect. We estimate the best exponent using the same methodology as that applied to our estimates of the duration, but without any filter correction (Fig. S2). In that case the best fitting exponent would be 4.5 (with a RMSE of 0.17). The results confirm that a cubic, $M_0 \alpha T^3$ (RMSE of 0.185) scaling is much more likely than a linear, $M_0 \alpha T$, scaling (RMSE of 0.58).

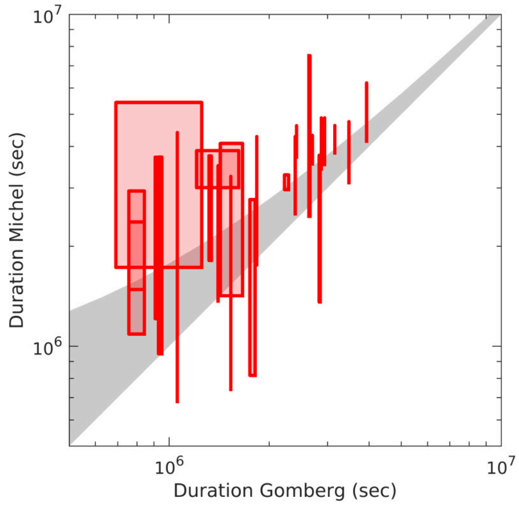


Fig. S1 | Comparison for tremor durations[13] and SSE durations derived from geodesy. The comparison is made for 24 common events. The uncertainties for the duration on the *y*-axis are given by our minimum/maximum duration estimations. The uncertainties on the *x*-axis are given by the minimum/maximum durations from abbreviated/entire tremor cluster catalogues (see ref.[13]). The lower boundary of the grey shaded area corresponds to a perfect fit. The upper boundary takes into account the approximate 9-day period cut-off of the filter.

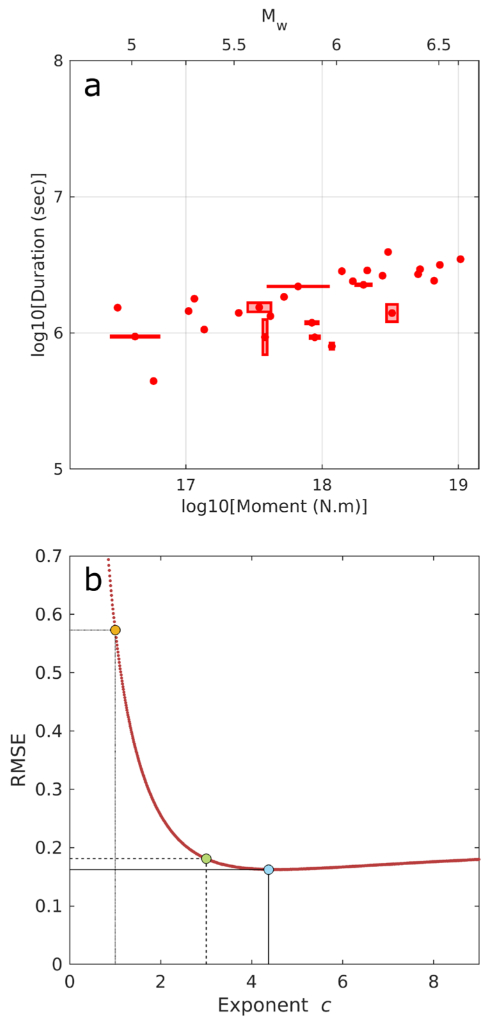
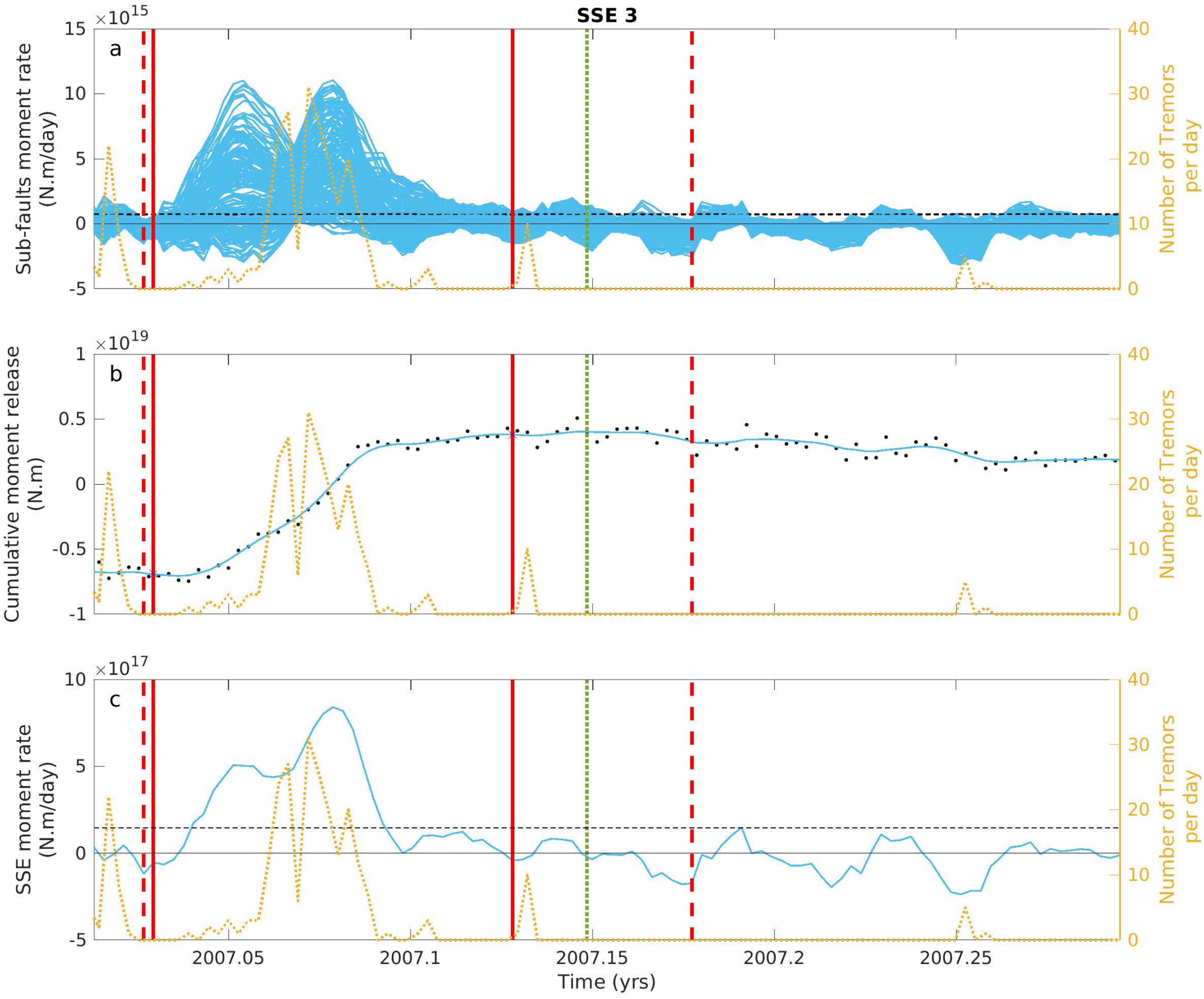


Fig. S2 | Moment–duration scaling laws obtained using only Gomberg duration estimates and their moment release estimates from our slip evolution model. a, Relationship between the moment, M_0, released by SSEs and their duration, T, using Gomberg SSE onsets and ends to calculate the moment release from our slip model. This plot is based on a revised version of the data set of ref.[10] (J. Gomberg, personal communication). **b**, Data fit assuming $M_0 \propto T^c$, taking into account the magnitude and duration uncertainties (see Methods). The RMSE for $c = 3$ (green filled circle) is a third of that for $c = 1$ (yellow). The best-fitting value is obtained for $c = 4.37$ (blue filled circle).

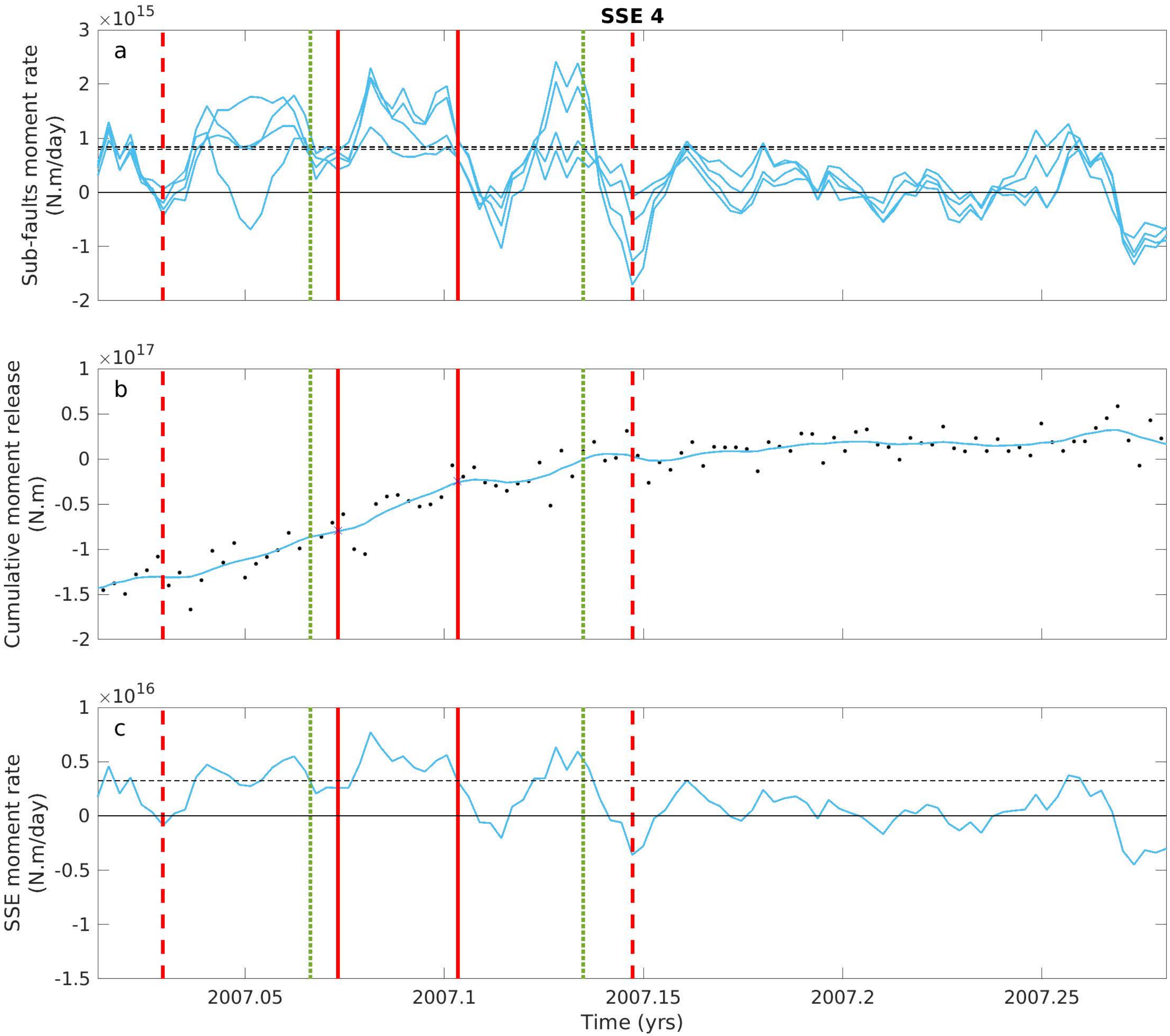
SSE source time functions, and SSEs onset and end times estimates explanation.

This section presents the source time functions of the Slow Slip Events analyzed in this study followed by explanations on how the onset and end times of each event were estimated. The SSE numbering is based on Michel et al.[15]. As indicated in the main text, certain events were combined due to their closeness in time and space, or removed if considered unreliable for the purpose of this study.

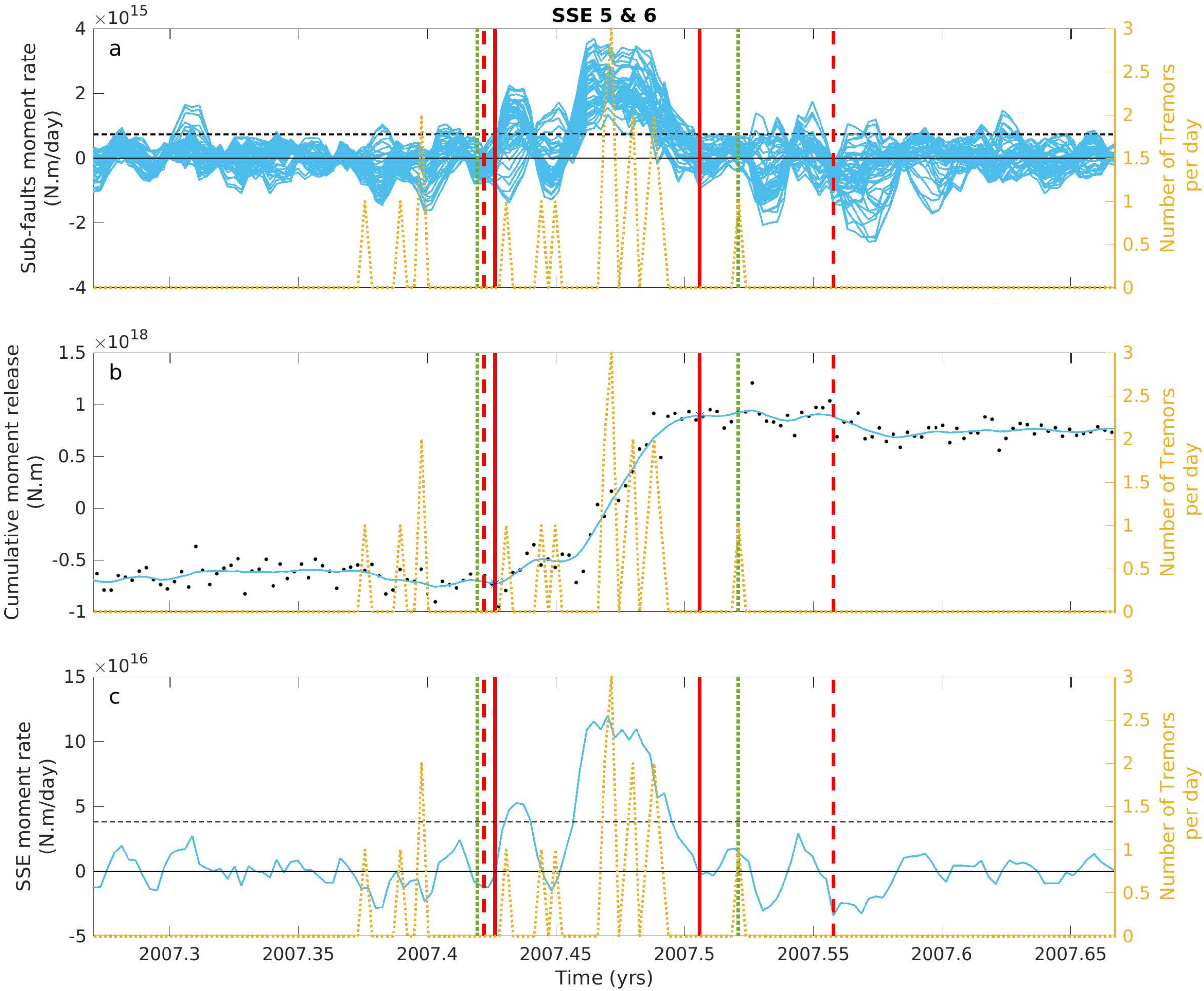
Hereafter each SSE is presented in one figure consisting of 3 panels. (a) The blue lines represent the moment rate evolution of each sub-fault participating in the SSE. The sub-faults moment rate is estimated using a zero-phase digital filtering on the rough δ_{deficit} using a 5-day window (effectively 9 days). The yellow line shows the number of tremors per day within the SSE area. The solid red lines indicate the manual SSEs start and end picks for the minimum duration estimate. They are determined based on the timing of the first and last subfault with of $\dot{M}_{0\,deficit} < \dot{M}_{0\,thresh}$, represented by the horizontal black dashed line. The dashed red lines indicate the manual SSEs start and end time picks for the maximum duration estimation. They are determined by the timing of the first and last sub-fault when $\dot{M}_{0\,deficit} < 0$. The dotted green lines indicate the automatically picked start and end times[15]. (b) The black dots indicate the cumulative moment release relative to the long-term interseismic moment release. The blue line is its smoothed version using the same filter as indicated in (a). The vertical red and green lines, and the yellow curve are the same as in (a). (c) The blue line indicates the SSE moment rate (sum of the moment rates of the SSE sub-faults). The horizontal dashed black line represents the $\dot{M}_{0\,thresh}$ sum of all the sub-faults. The red, yellow and green lines are the same as in (a).



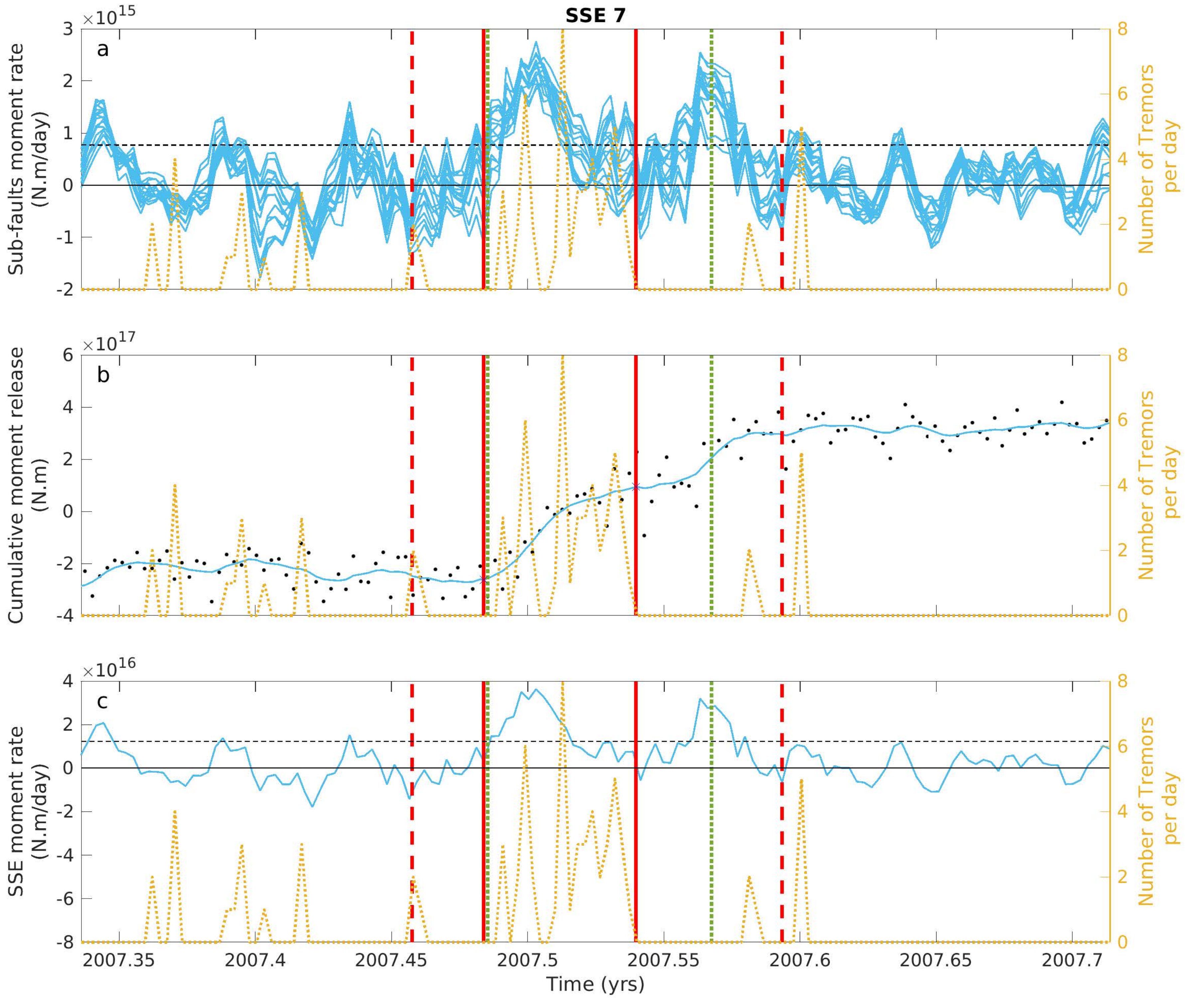
SSE 3
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
$\times 10^{15}$
$\times 10^{19}$
$\times 10^{17}$
2007.05
2007.1
2007.15
2007.2
2007.25
Time (yrs)

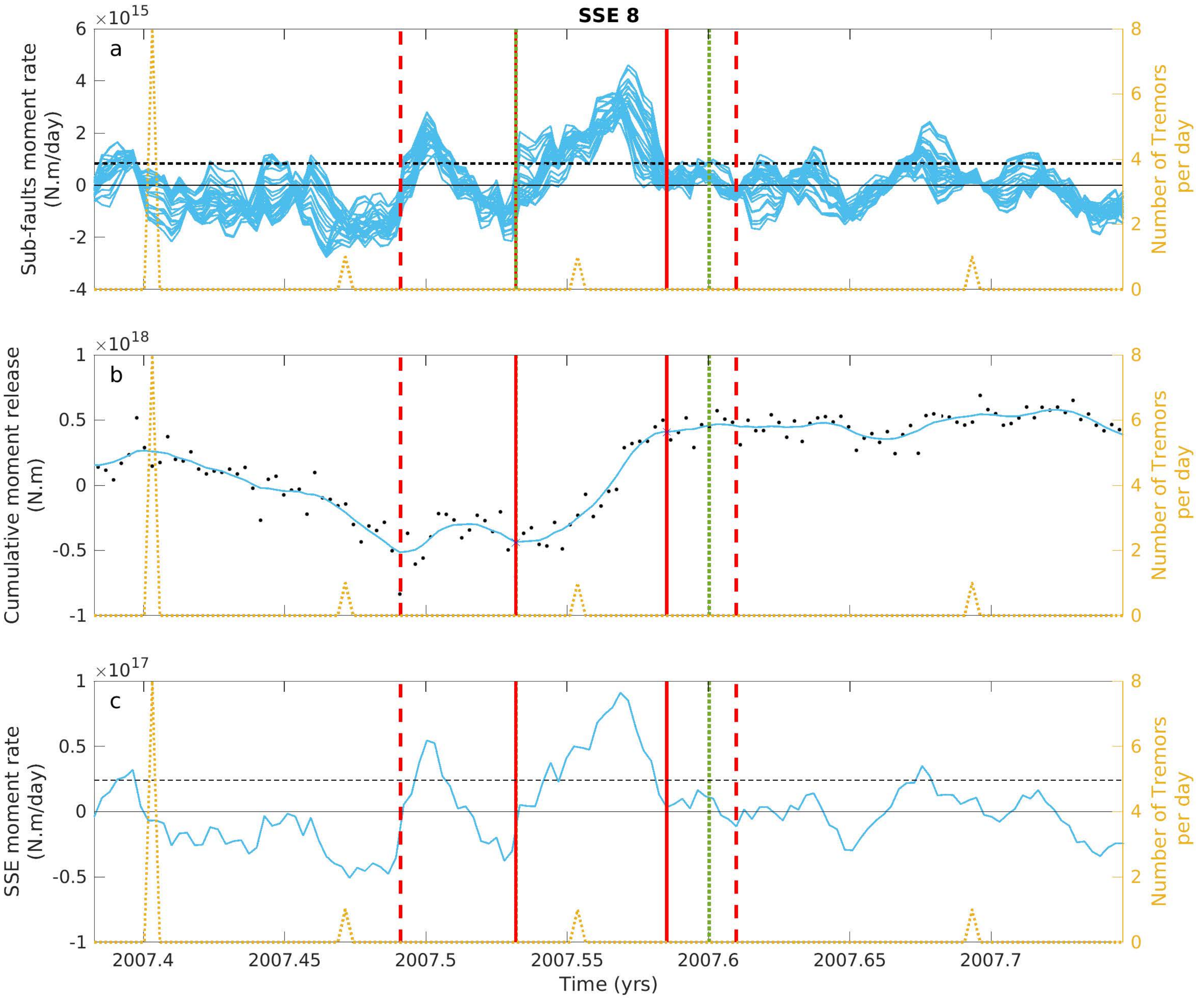


SSE 4
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
×10^15
×10^17
×10^16
3
2
1
0
-1
-2
0.5
-0.5
-1.5
2007.05
2007.1
2007.15
2007.2
2007.25
Time (yrs)

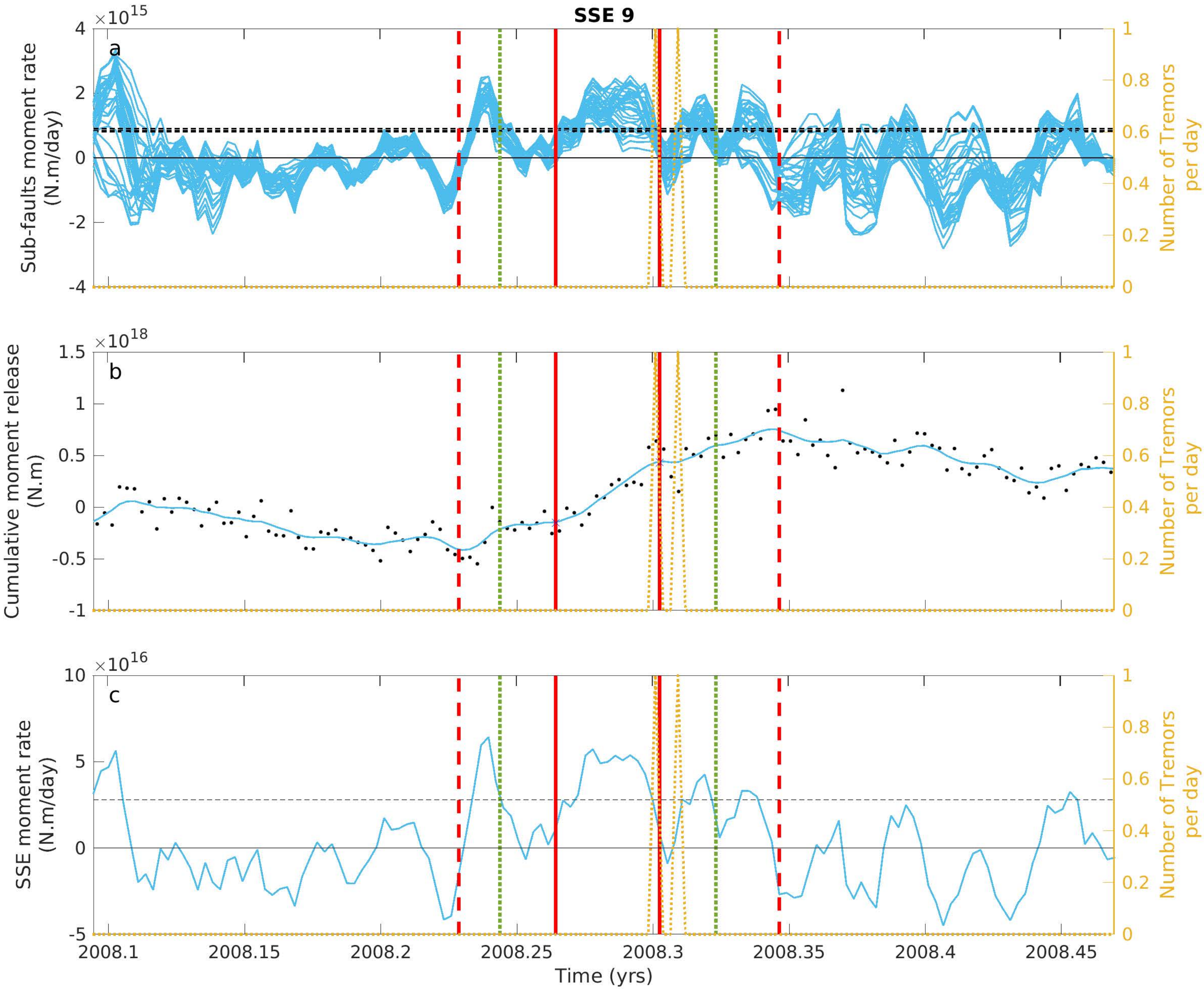


SSE 5 & 6
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^18
×10^16
Time (yrs)
2007.3
2007.35
2007.4
2007.45
2007.5
2007.55
2007.6
2007.65

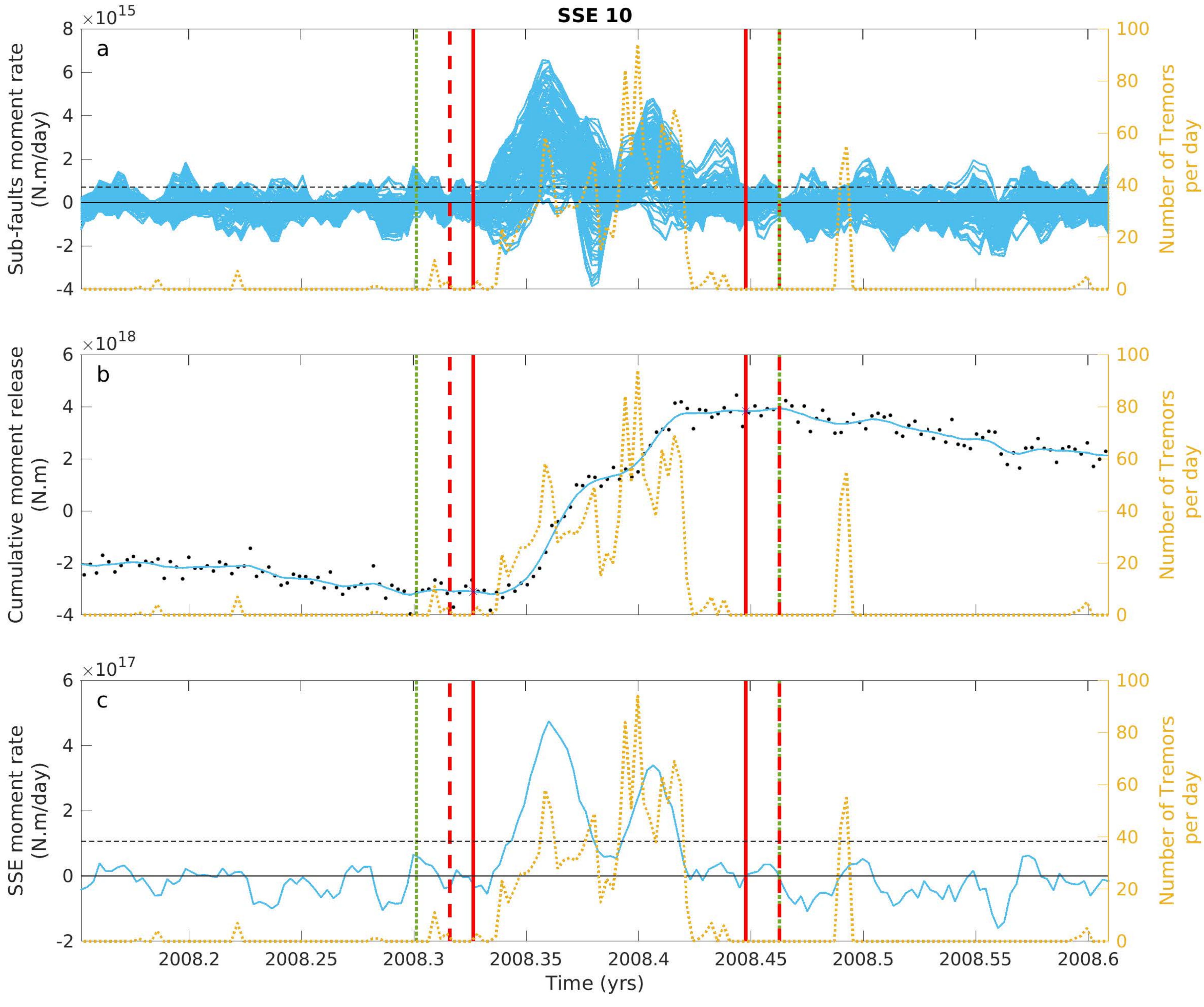

SSE 7
a
b
c
×10^15
×10^17
×10^16
Sub-faults moment rate
(N.m/day)
Cumulative moment release
(N.m)
SSE moment rate
(N.m/day)
Number of Tremors
per day
Time (yrs)
2007.35
2007.4
2007.45
2007.5
2007.55
2007.6
2007.65
2007.7



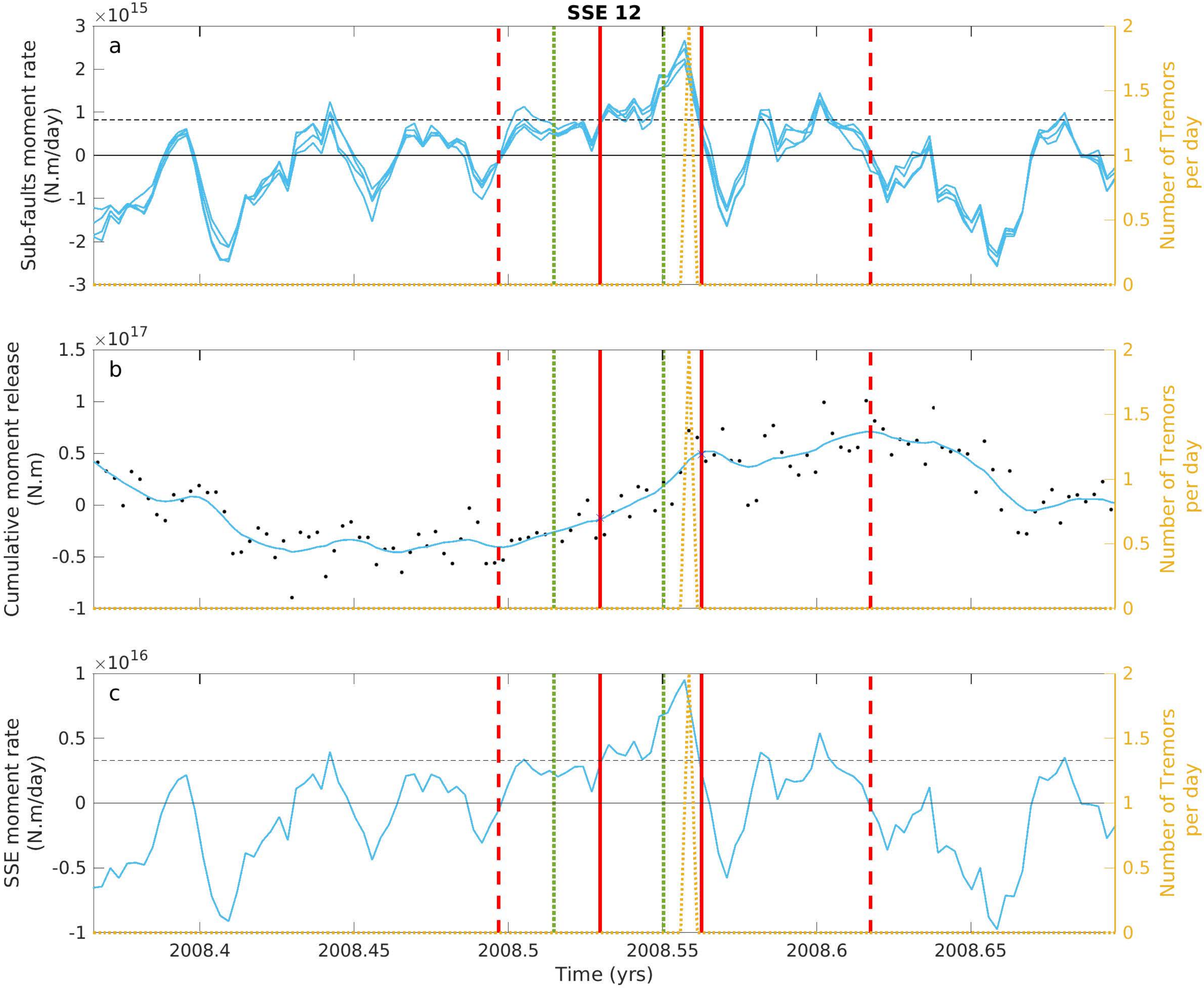
SSE 8
a
b
c
×10^15
×10^18
×10^17
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
2007.4
2007.45
2007.5
2007.55
2007.6
2007.65
2007.7
Time (yrs)

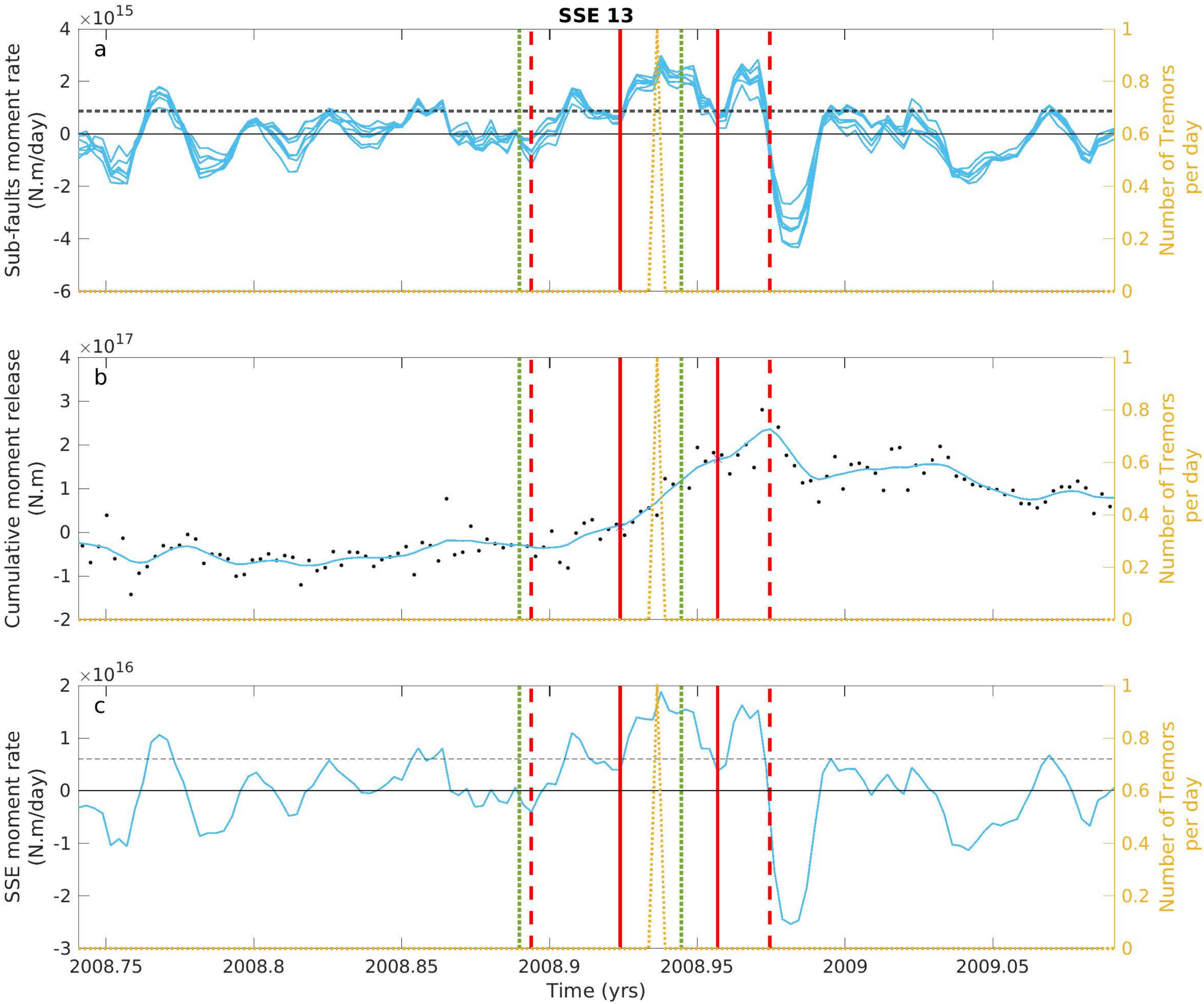


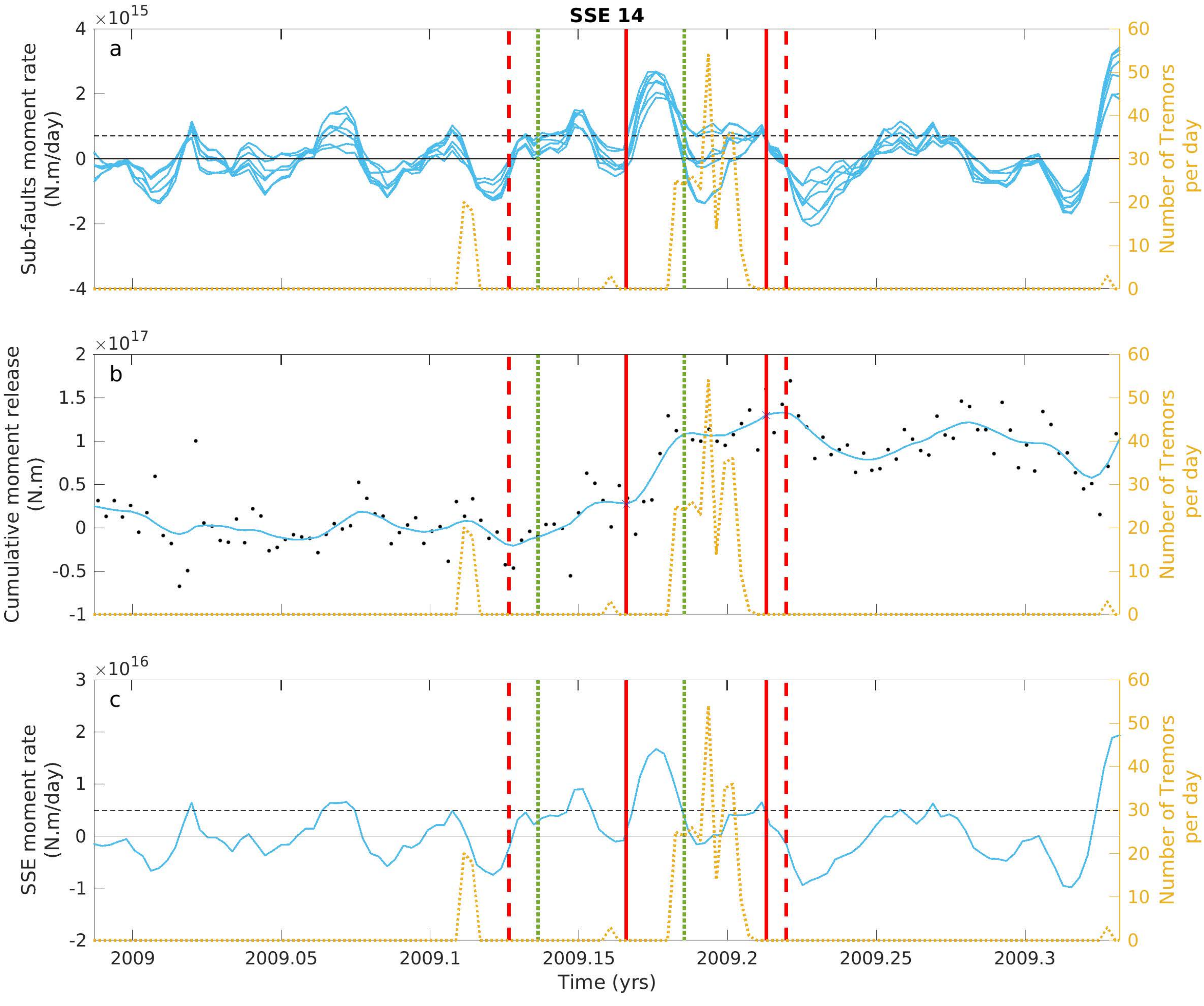
SSE 9
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
×10^15
×10^18
×10^16
2008.1
2008.15
2008.2
2008.25
2008.3
2008.35
2008.4
2008.45



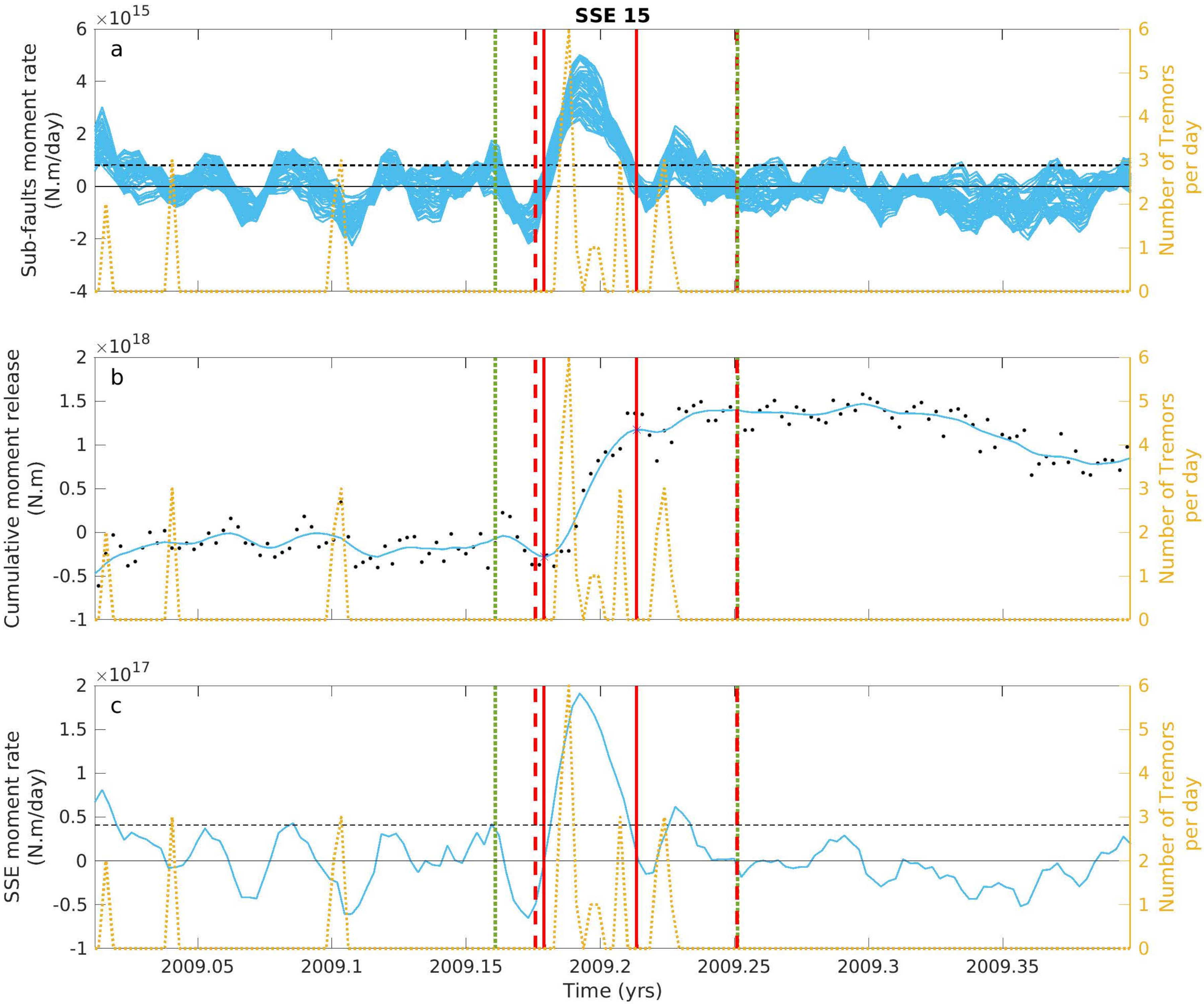
SSE 10
a
b
c
$\times 10^{15}$
$\times 10^{18}$
$\times 10^{17}$
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
2008.2
2008.25
2008.3
2008.35
2008.4
2008.45
2008.5
2008.55
2008.6


SSE 12
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^17
×10^16
Time (yrs)
2008.4
2008.45
2008.5
2008.55
2008.6
2008.65

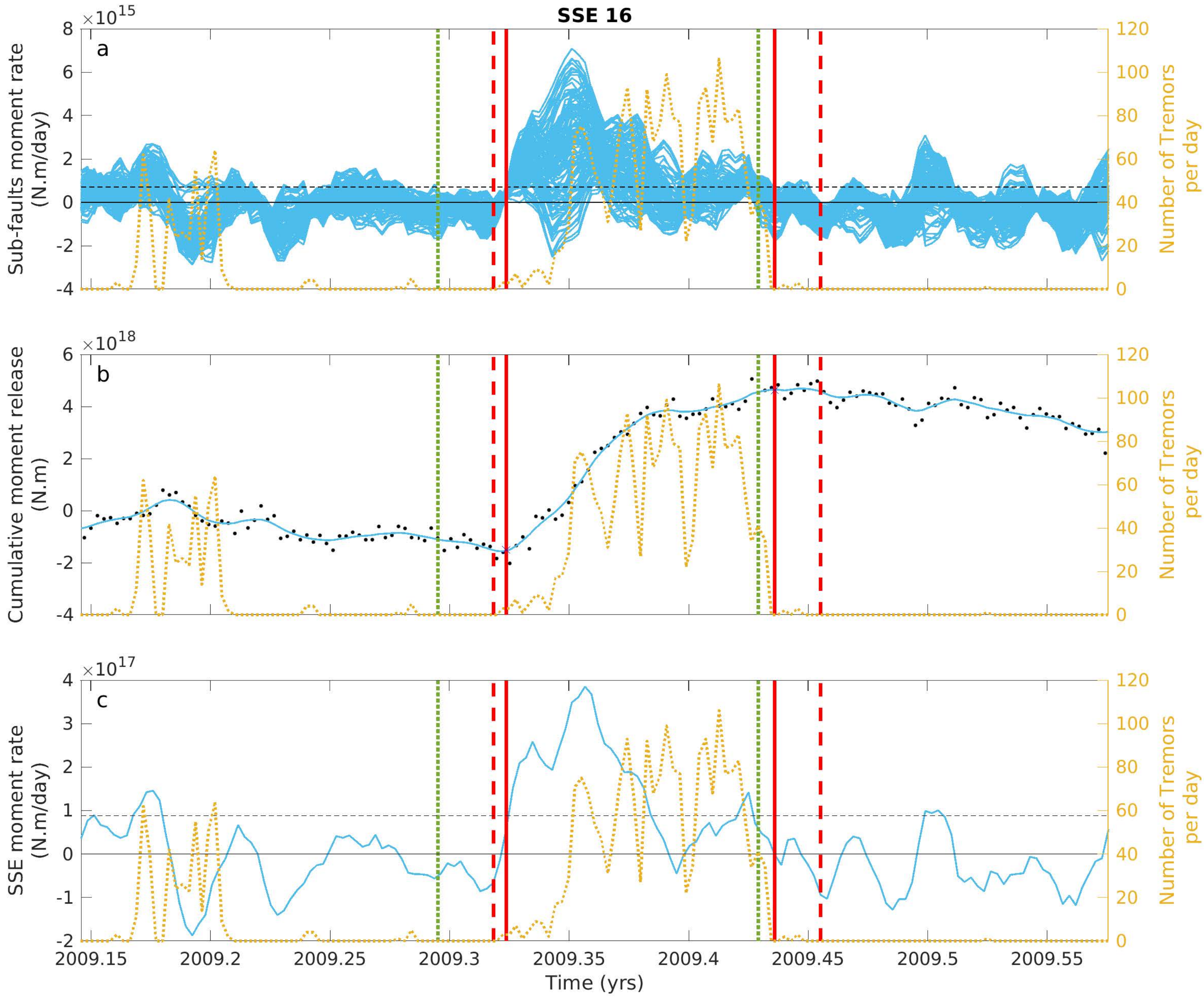

SSE 13
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
2008.75
2008.8
2008.85
2008.9
2008.95
2009
2009.05
×10^15
×10^17
×10^16

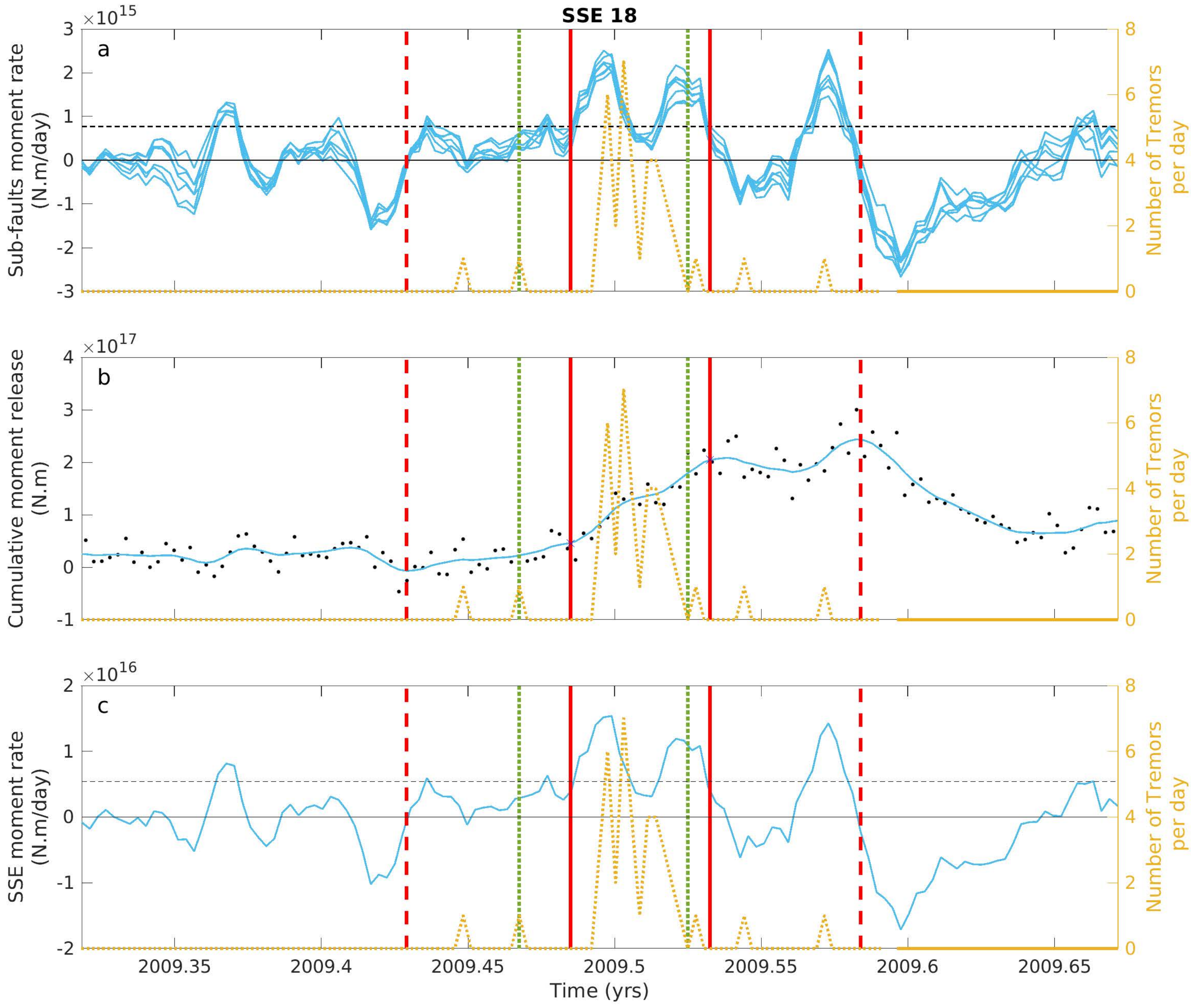


SSE 14
a
b
c
×10^15
×10^17
×10^16
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
2009
2009.05
2009.1
2009.15
2009.2
2009.25
2009.3

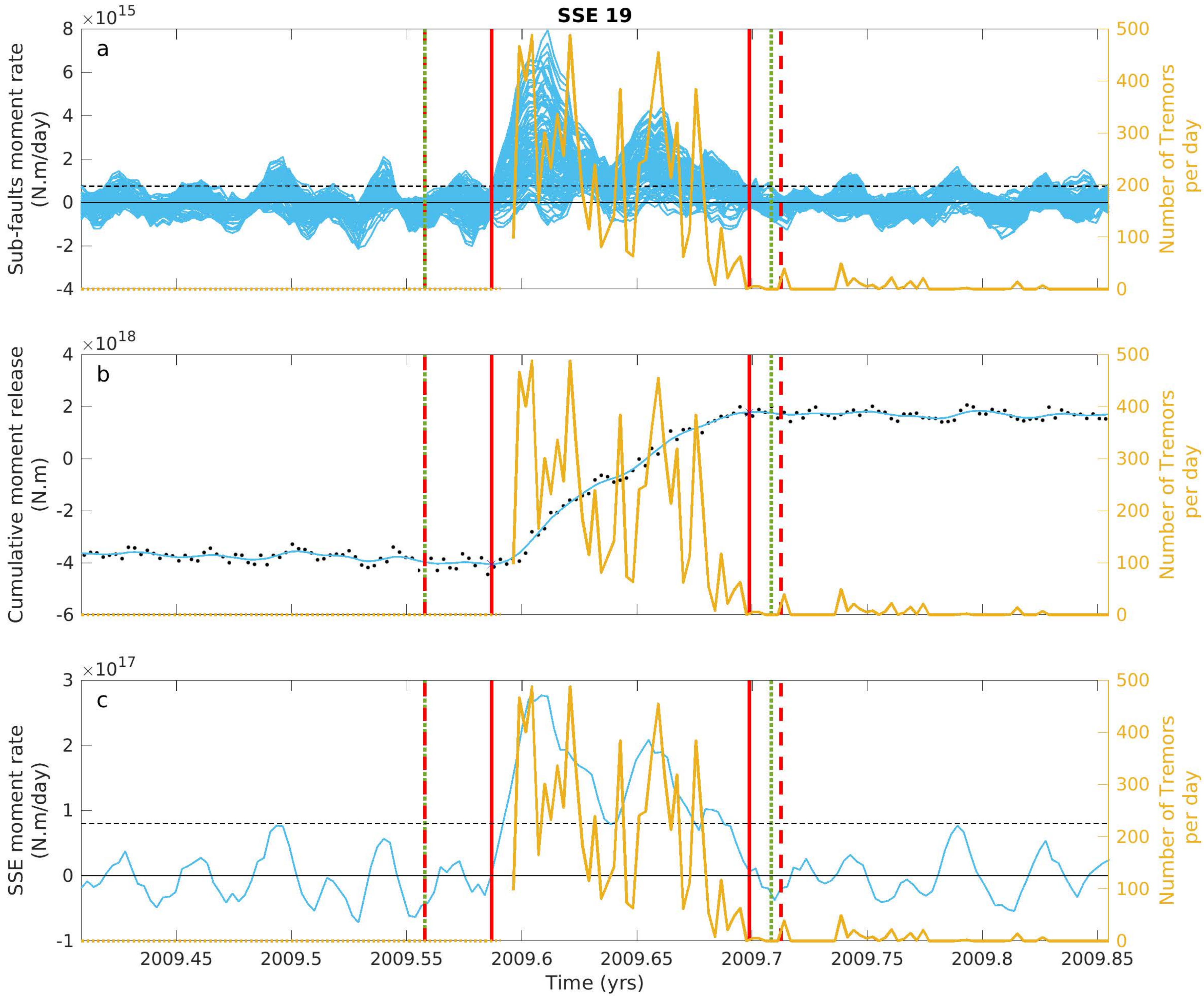


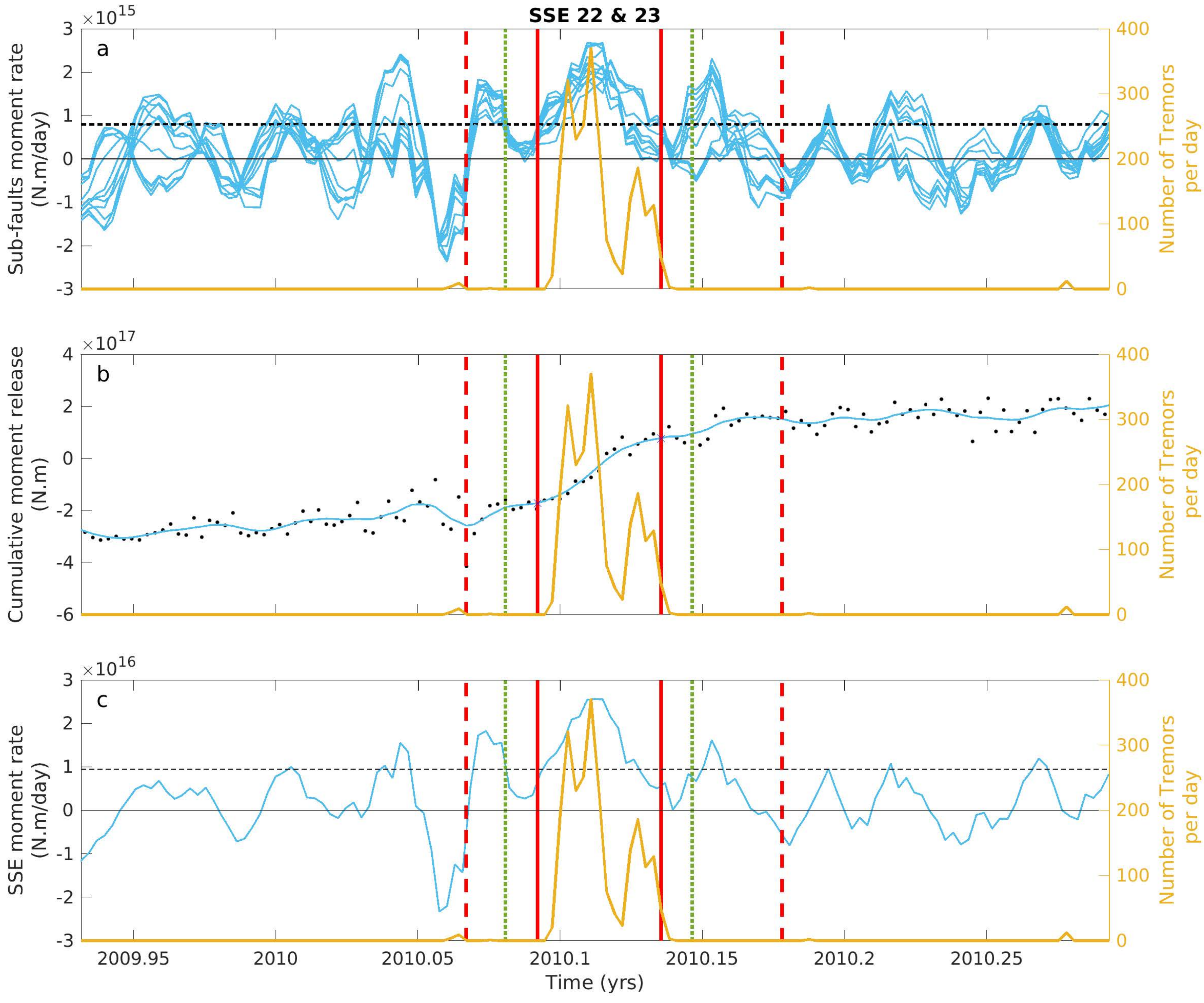
SSE 15
a
b
c
×10^15
×10^18
×10^17
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
2009.05
2009.1
2009.15
2009.2
2009.25
2009.3
2009.35

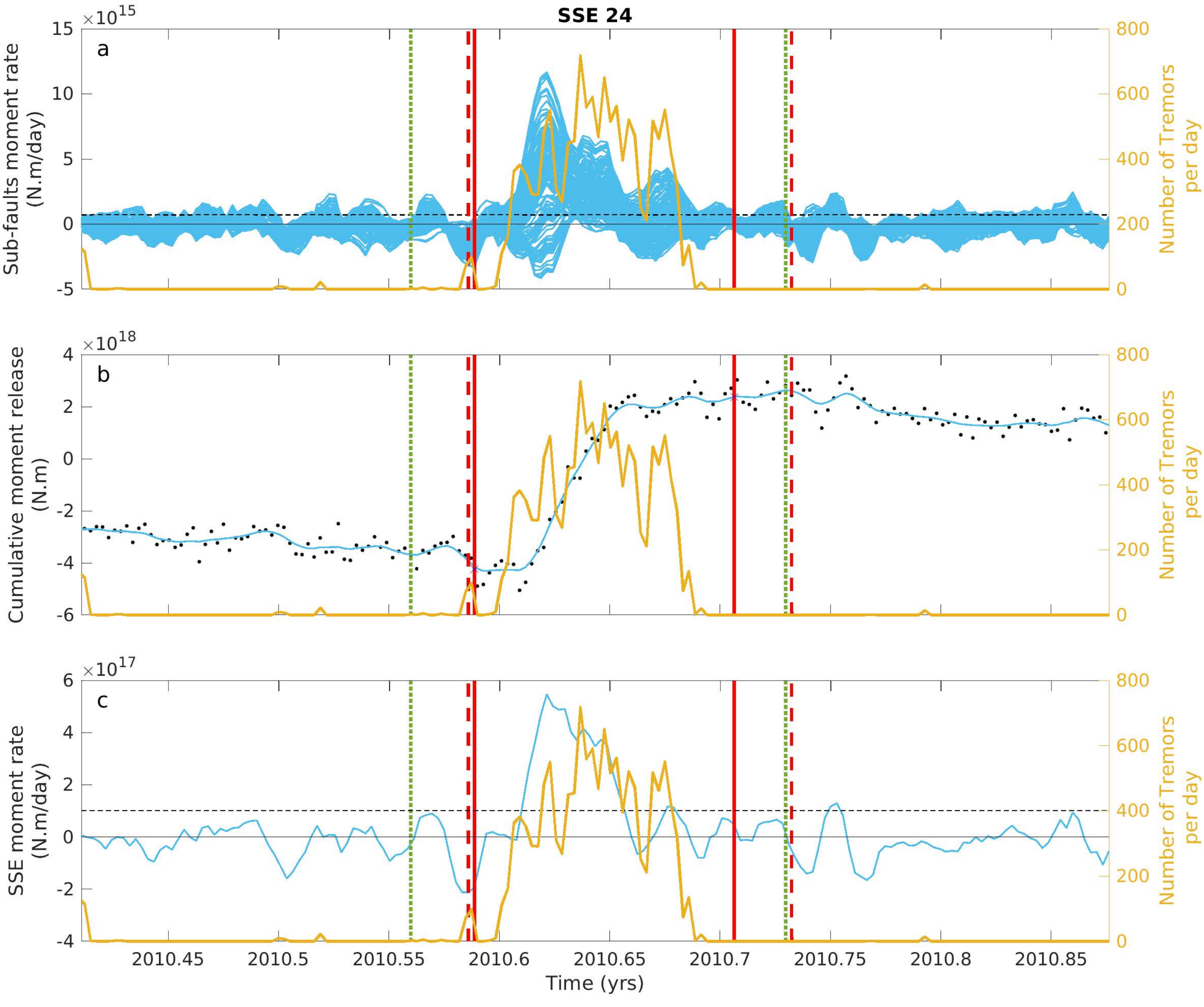

SSE 16
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^18
×10^17
Time (yrs)
2009.15
2009.2
2009.25
2009.3
2009.35
2009.4
2009.45
2009.5
2009.55



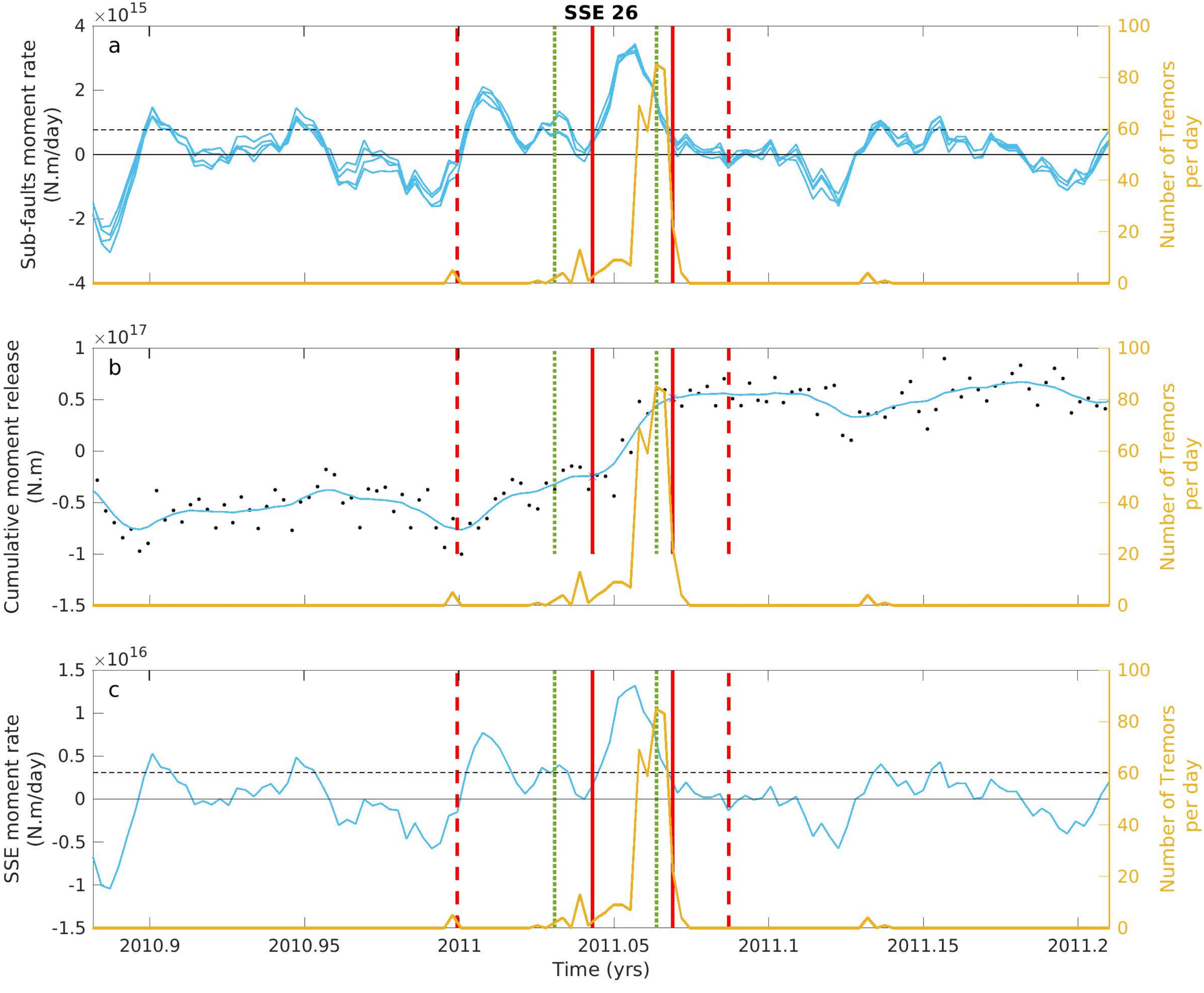
SSE 18
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^17
×10^16
2009.35
2009.4
2009.45
2009.5
2009.55
2009.6
2009.65
Time (yrs)


SSE 19
a
b
c
Sub-faults moment rate
(N.m/day)
Cumulative moment release
(N.m)
SSE moment rate
(N.m/day)
Number of Tremors
per day
×10^15
×10^18
×10^17
Time (yrs)
2009.45
2009.5
2009.55
2009.6
2009.65
2009.7
2009.75
2009.8
2009.85

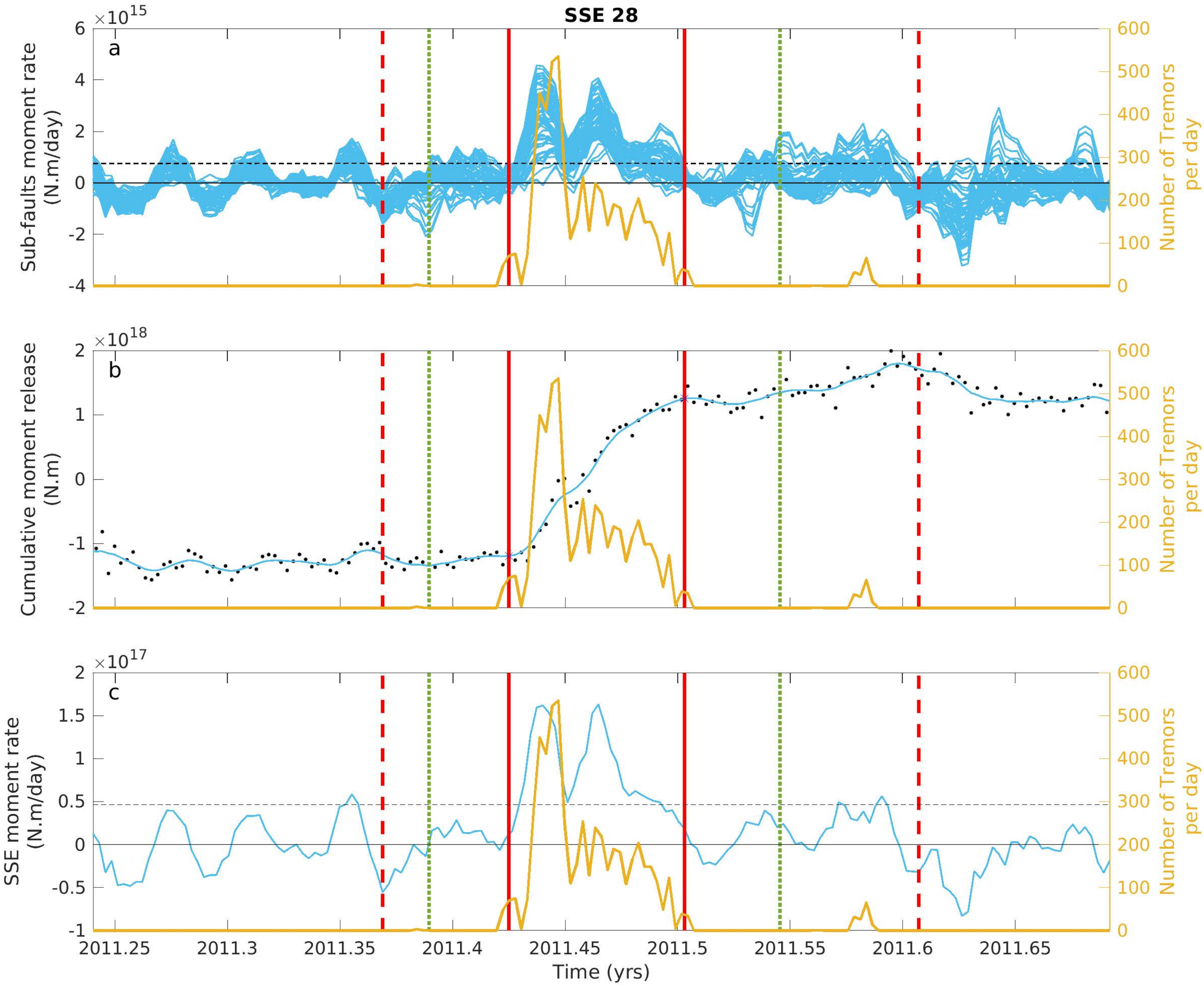

SSE 22 & 23
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
2009.95
2010
2010.05
2010.1
2010.15
2010.2
2010.25



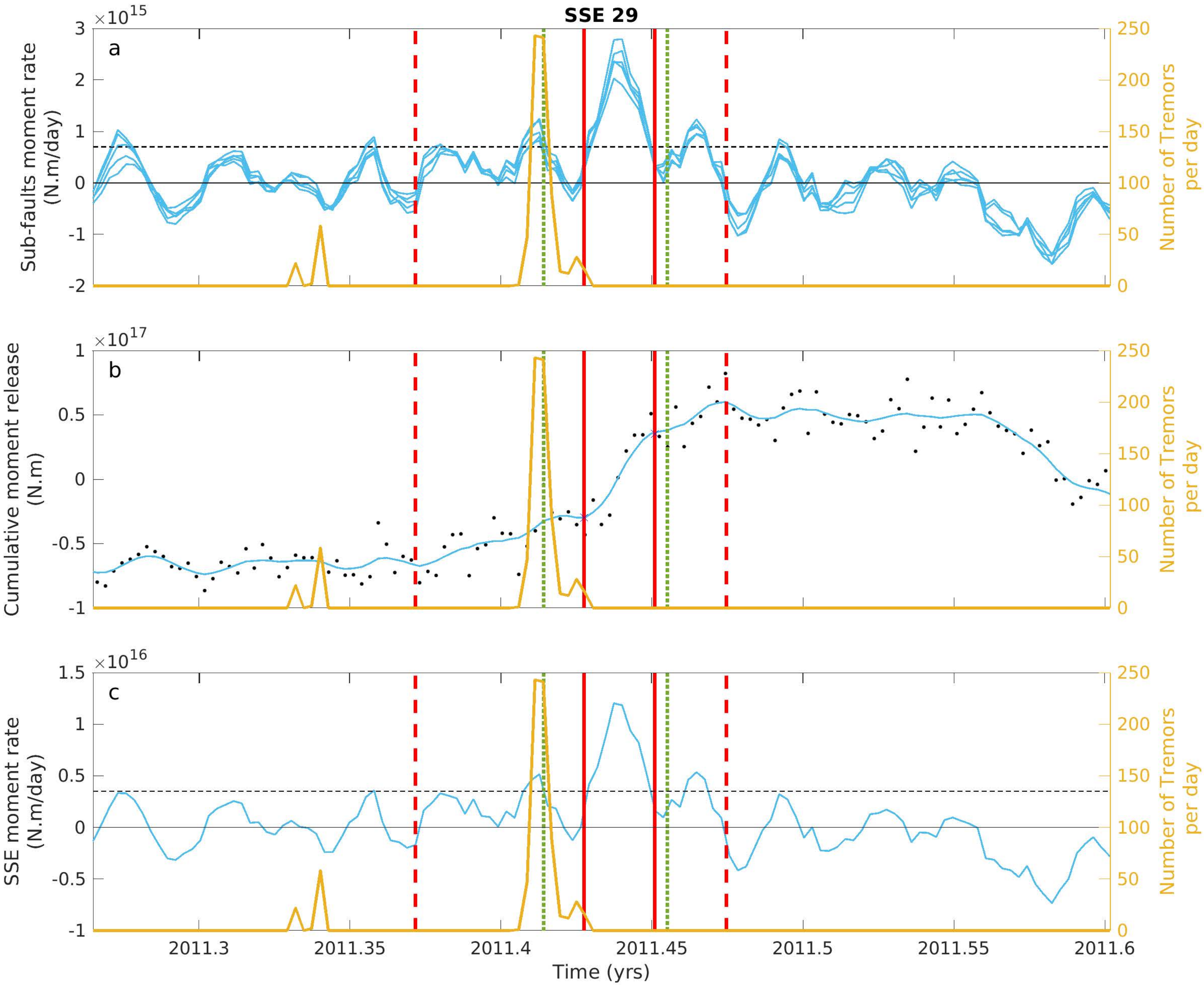
SSE 24
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^18
×10^17
Time (yrs)
2010.45
2010.5
2010.55
2010.6
2010.65
2010.7
2010.75
2010.8
2010.85


SSE 26
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
$\times 10^{15}$
$\times 10^{17}$
$\times 10^{16}$
2010.9
2010.95
2011
2011.05
2011.1
2011.15
2011.2

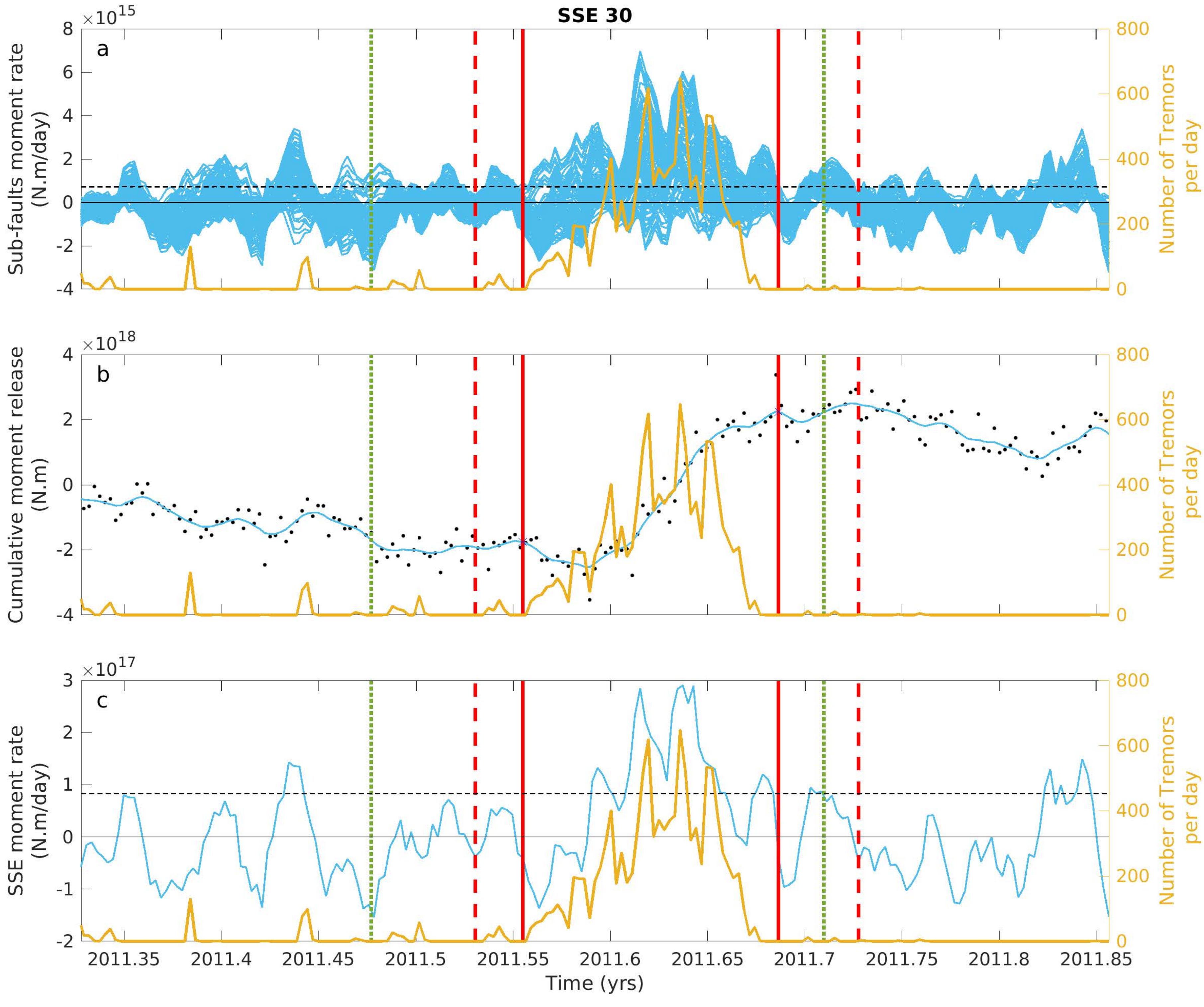
SSE 27
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)



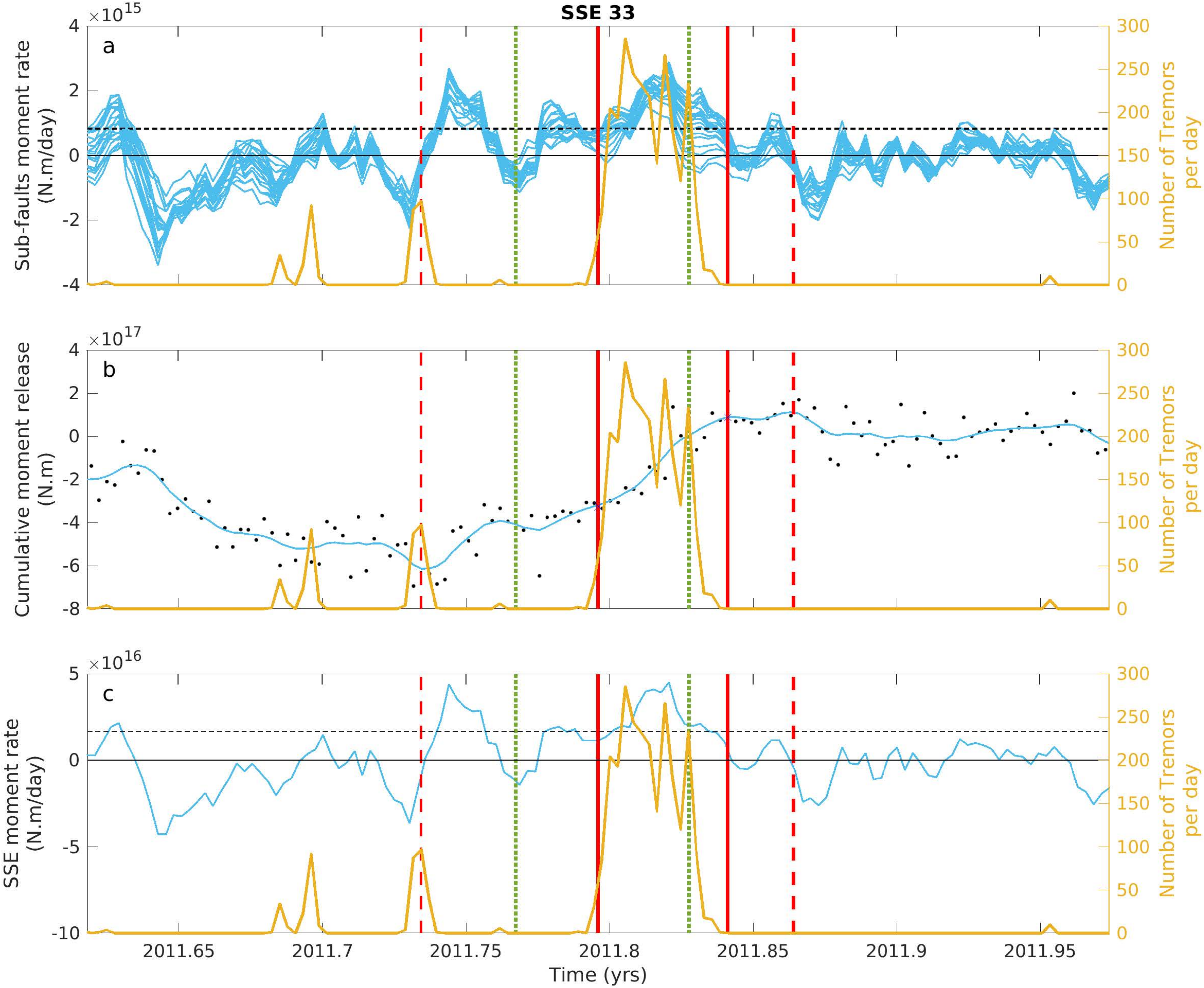
SSE 28
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^18
×10^17
Time (yrs)
2011.25
2011.3
2011.35
2011.4
2011.45
2011.5
2011.55
2011.6
2011.65



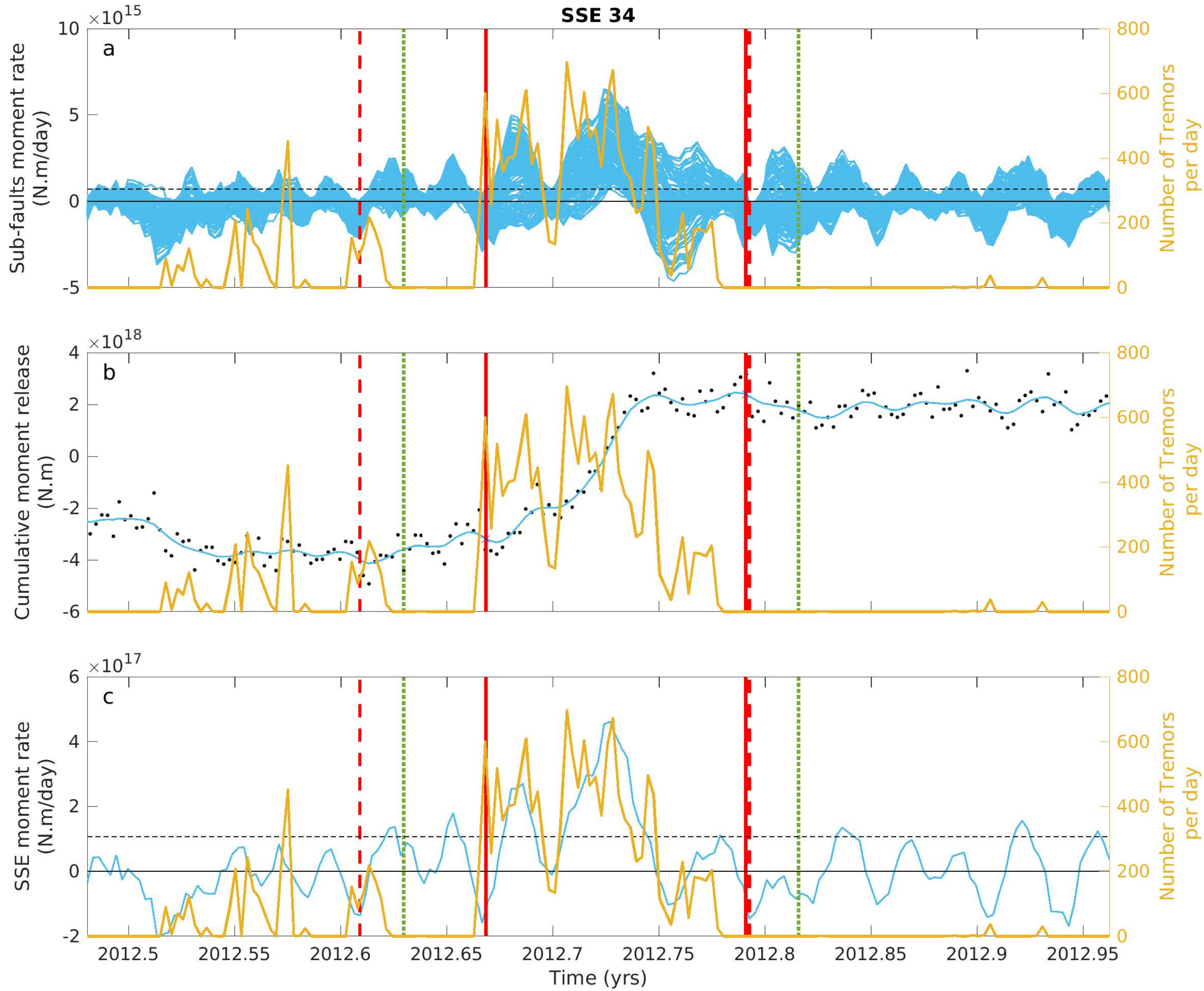
SSE 29
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^17
×10^16
Time (yrs)
2011.3
2011.35
2011.4
2011.45
2011.5
2011.55
2011.6



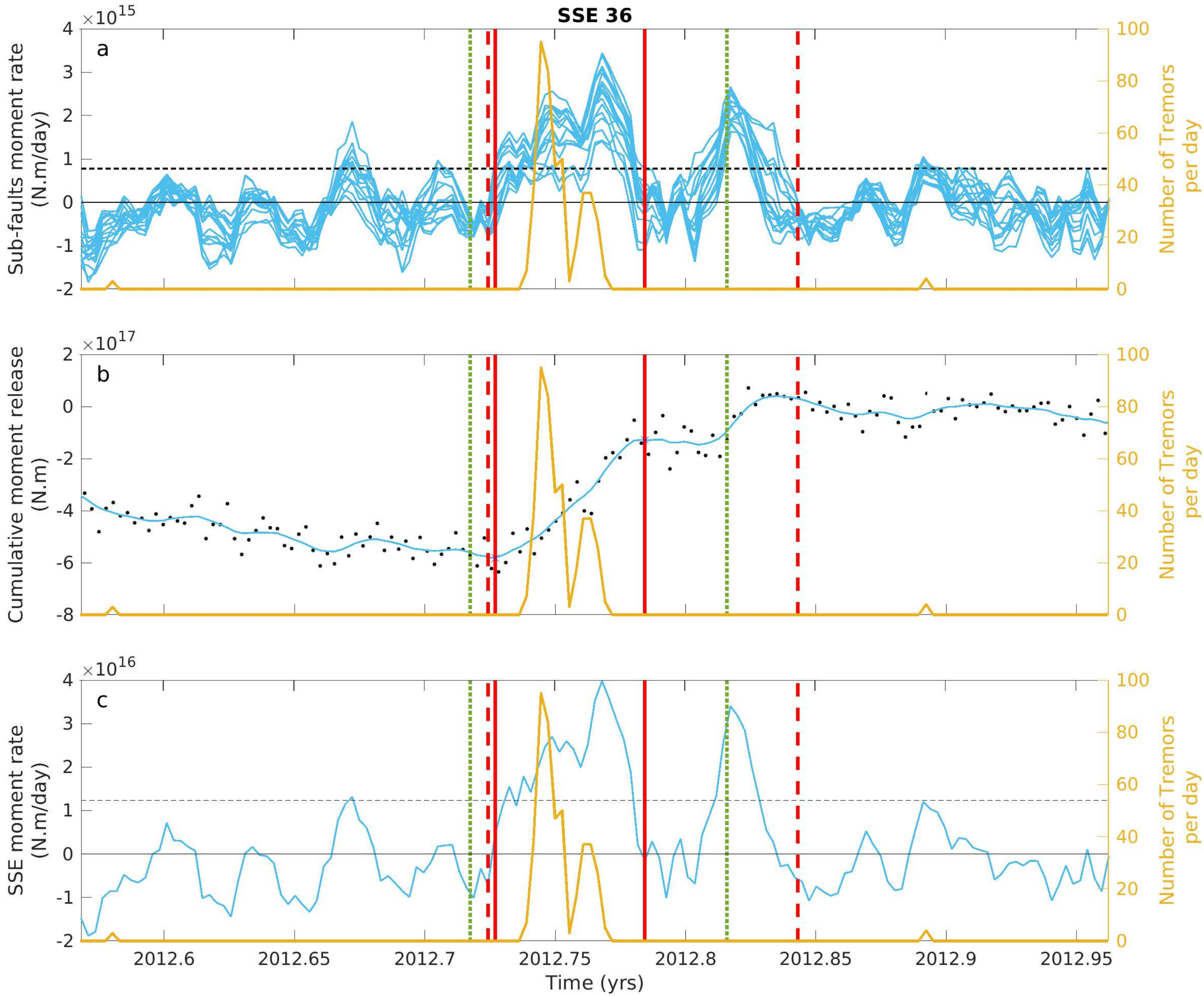
SSE 30
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
×10^15
×10^18
×10^17

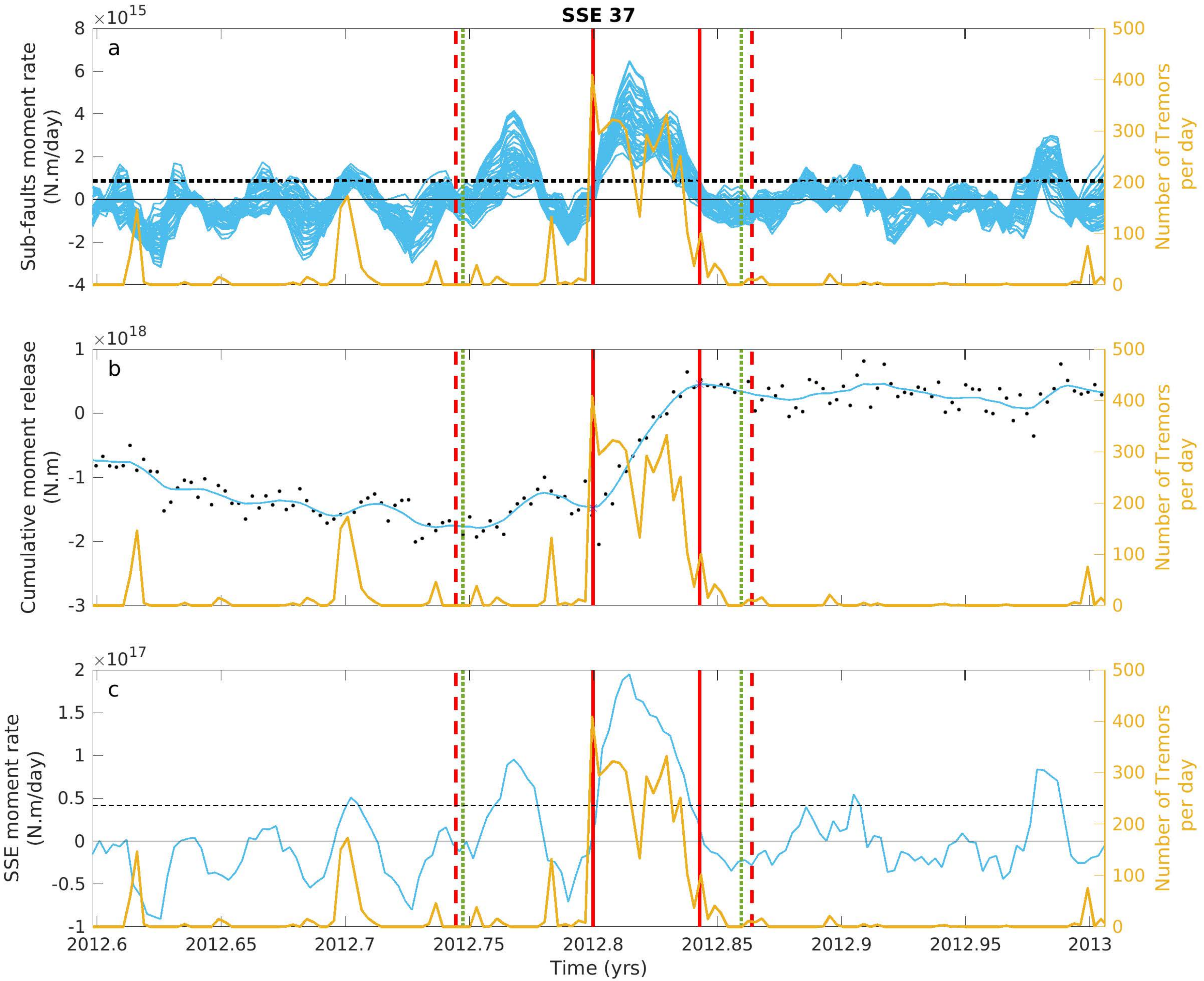


SSE 33
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)

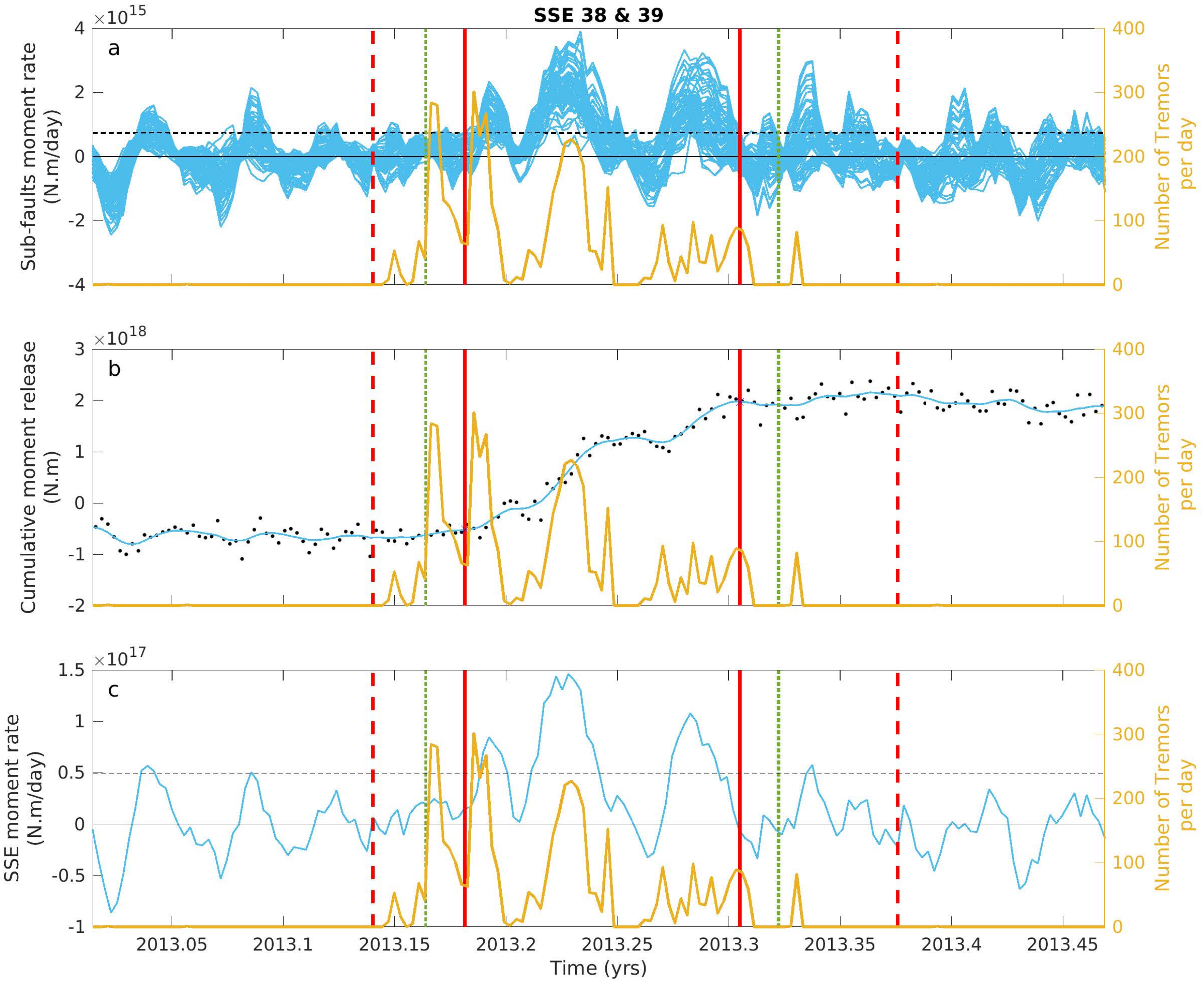


SSE 34
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
$\times 10^{15}$
$\times 10^{18}$
$\times 10^{17}$
Time (yrs)
2012.5
2012.55
2012.6
2012.65
2012.7
2012.75
2012.8
2012.85
2012.9
2012.95

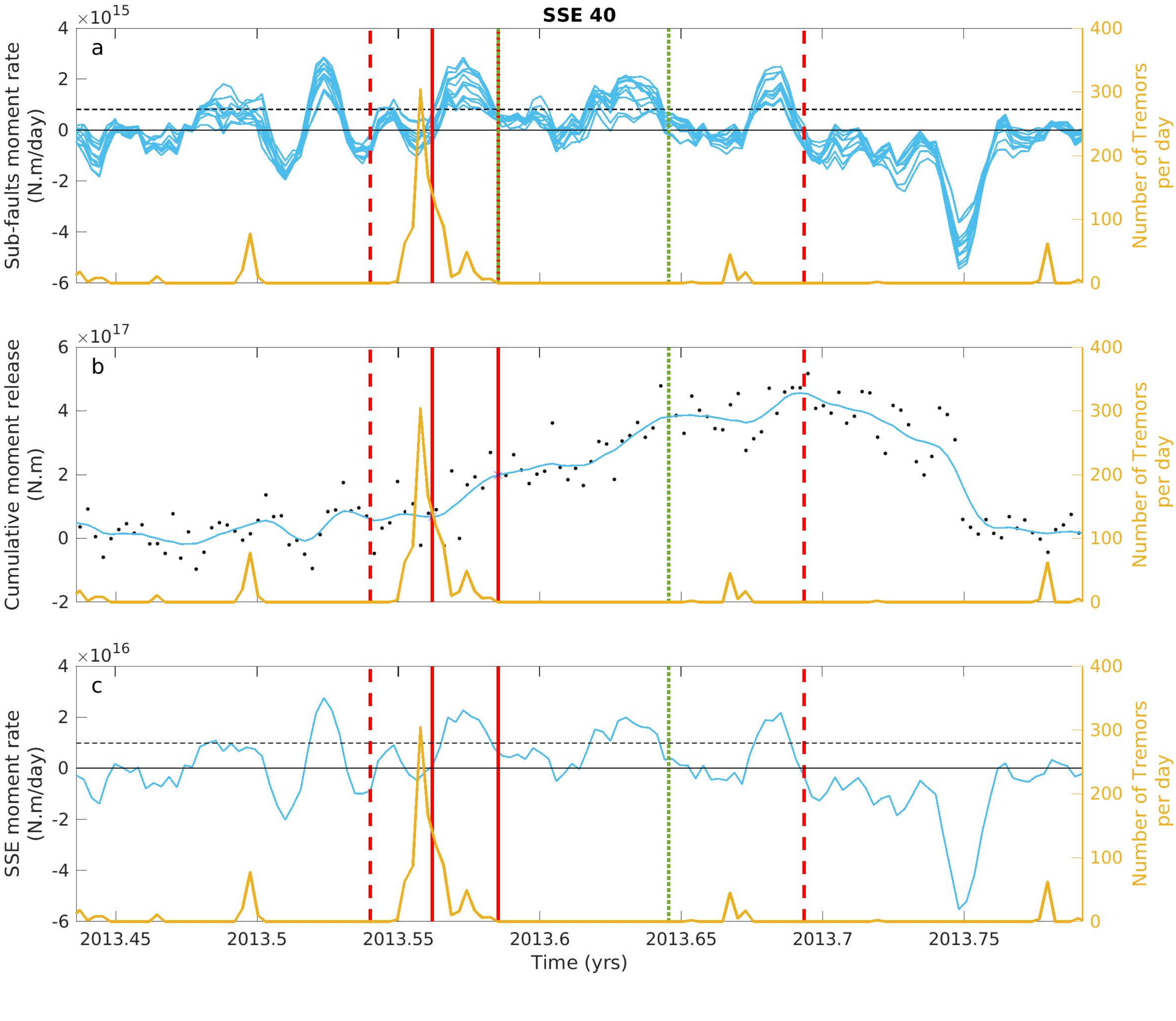

SSE 36
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
$\times 10^{15}$
$\times 10^{17}$
$\times 10^{16}$
2012.6
2012.65
2012.7
2012.75
2012.8
2012.85
2012.9
2012.95



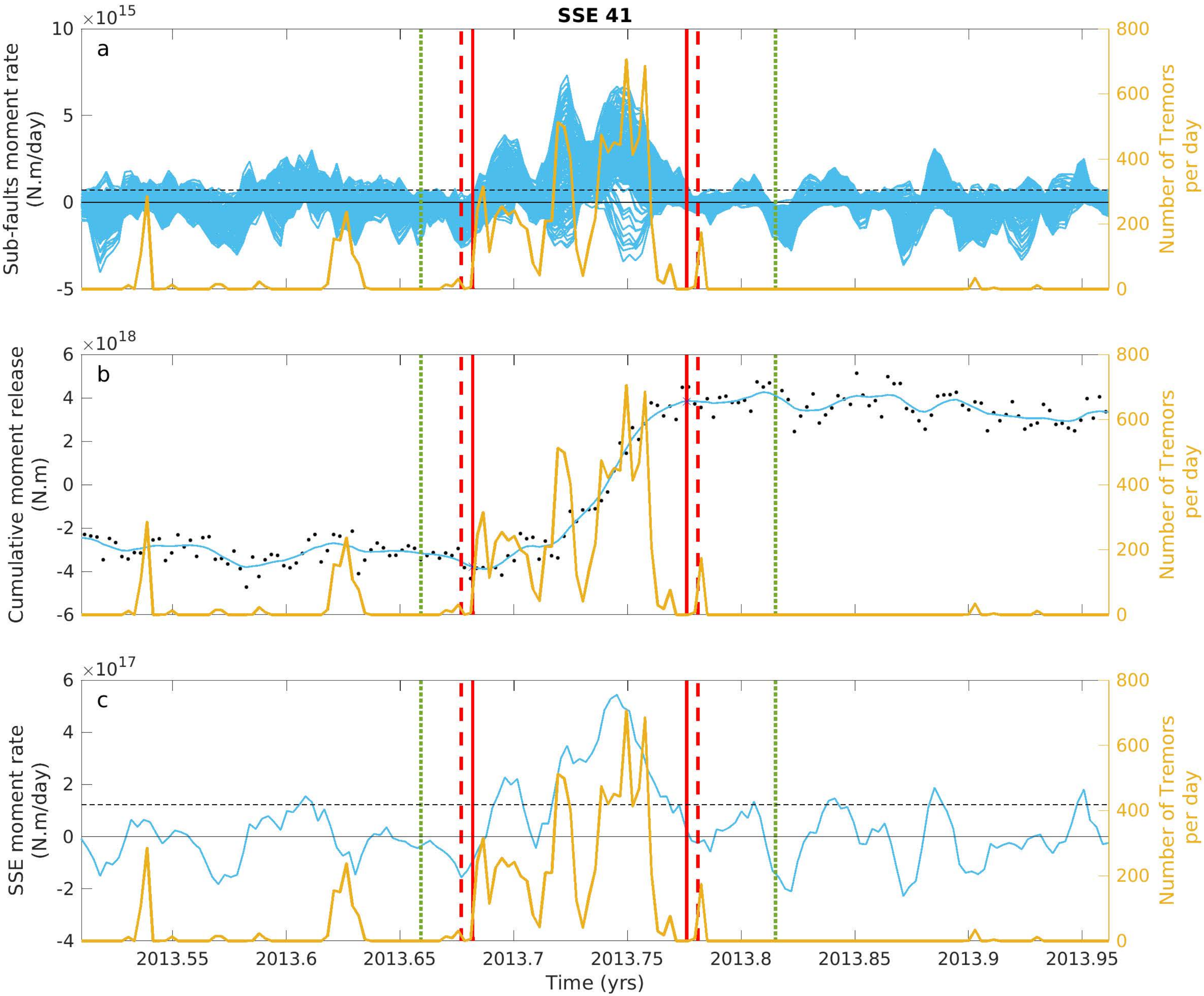
SSE 37
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
$\times 10^{15}$
$\times 10^{18}$
$\times 10^{17}$



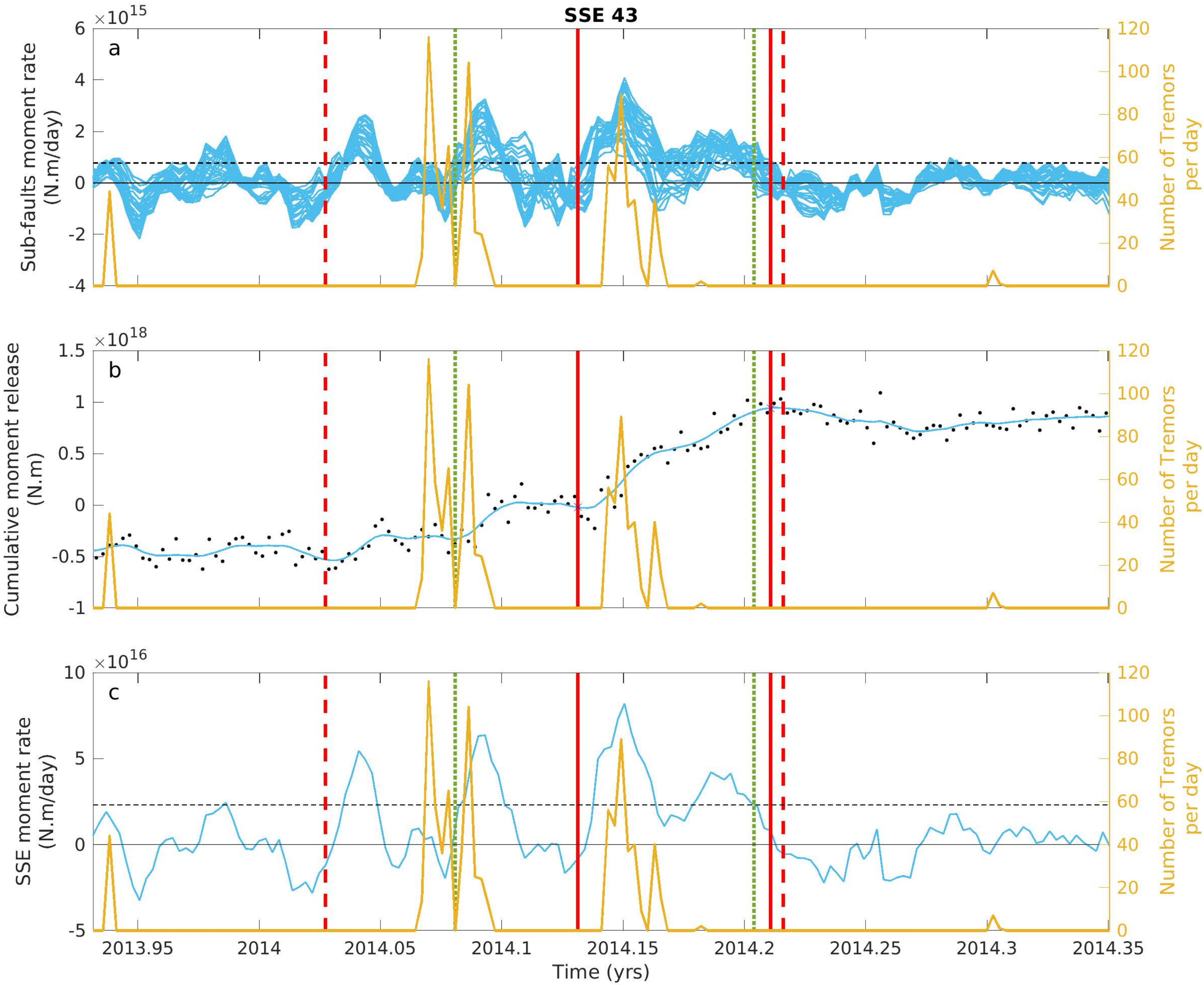
SSE 38 & 39
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^18
×10^17
Time (yrs)
2013.05
2013.1
2013.15
2013.2
2013.25
2013.3
2013.35
2013.4
2013.45



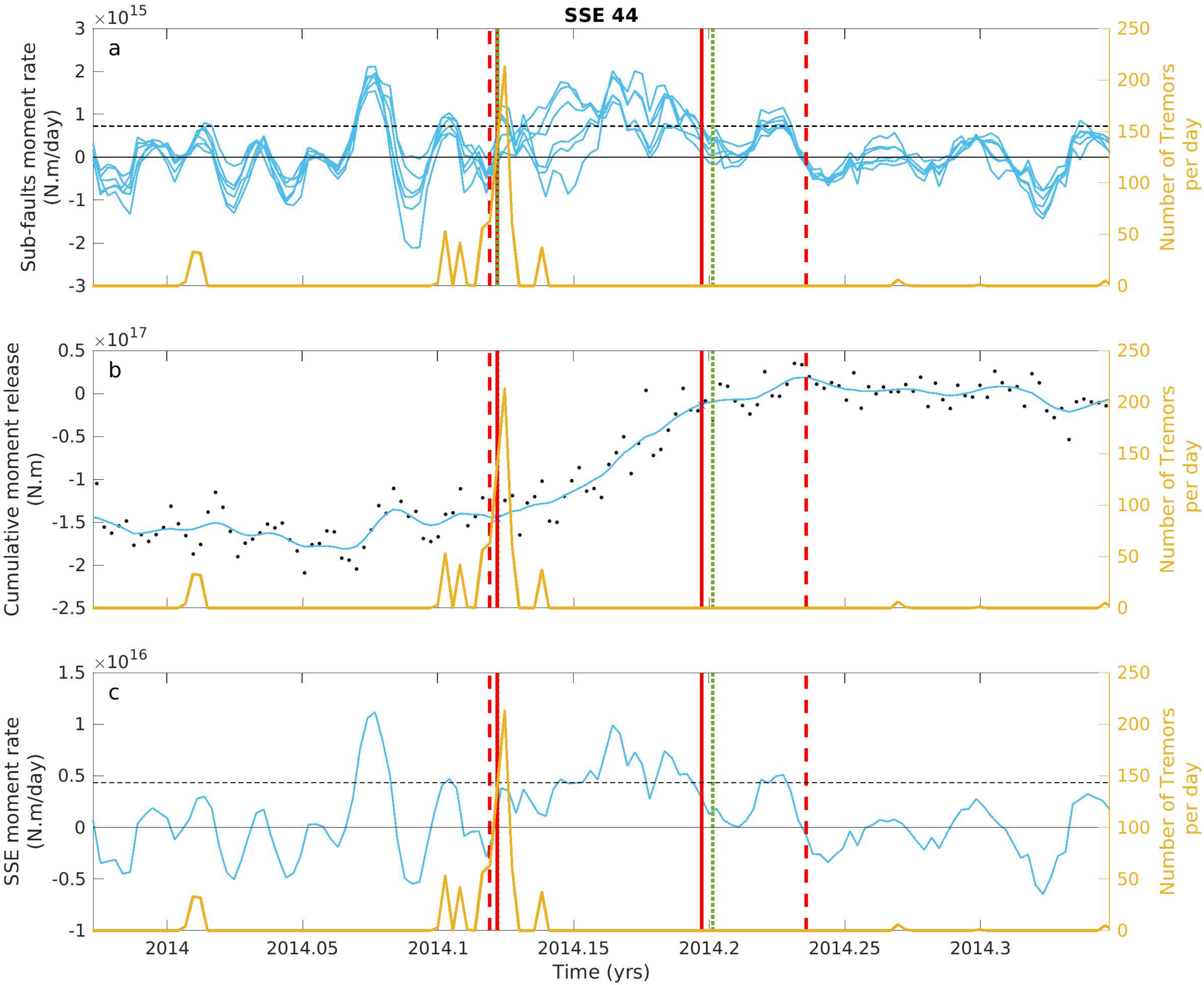
SSE 40
a
b
c
$\times10^{15}$
$\times10^{17}$
$\times10^{16}$
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
4
2
0
-2
-4
-6
6
400
300
200
100
2013.45
2013.5
2013.55
2013.6
2013.65
2013.7
2013.75
Time (yrs)

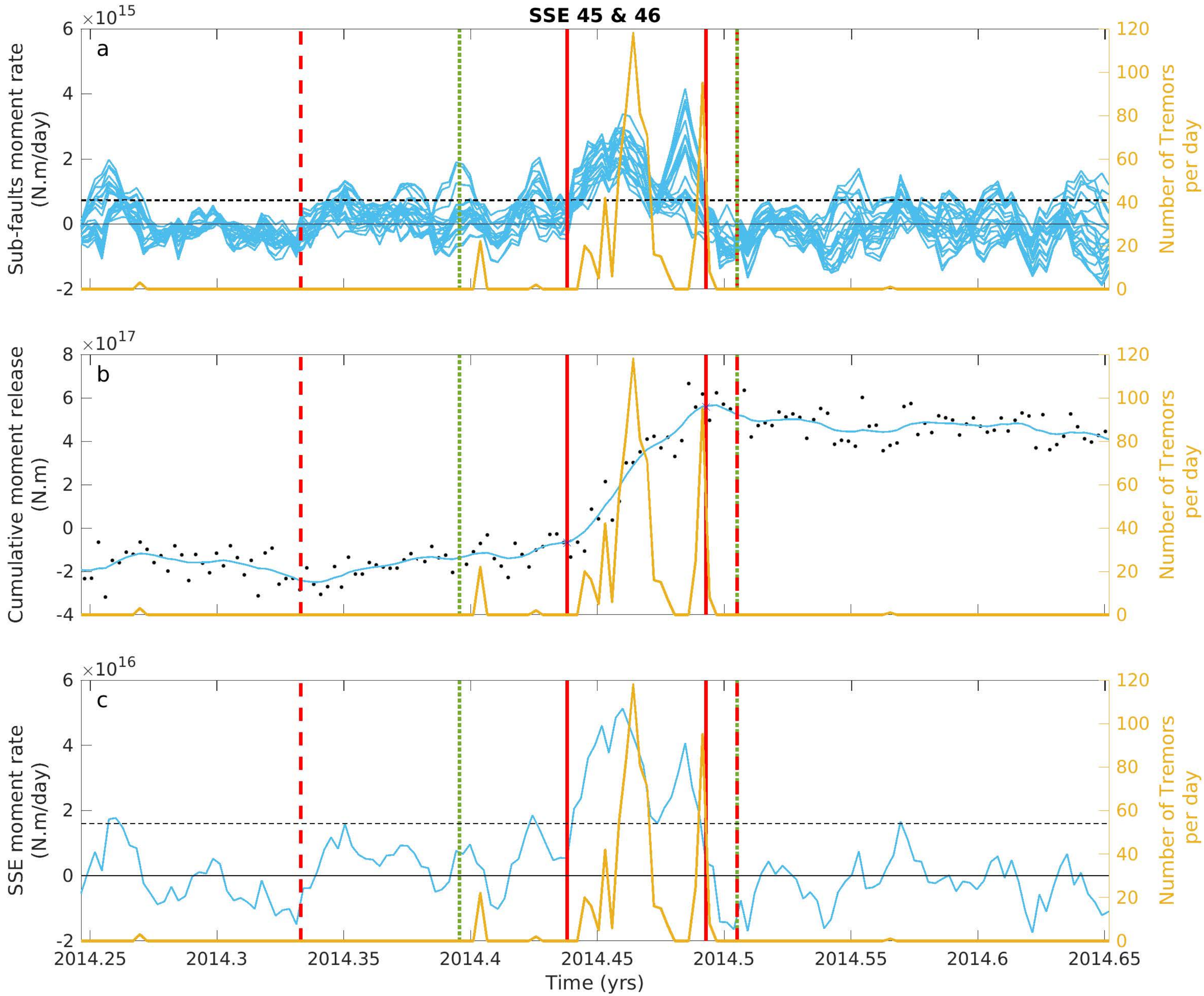


SSE 41
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^18
×10^17
Time (yrs)
2013.55
2013.6
2013.65
2013.7
2013.75
2013.8
2013.85
2013.9
2013.95

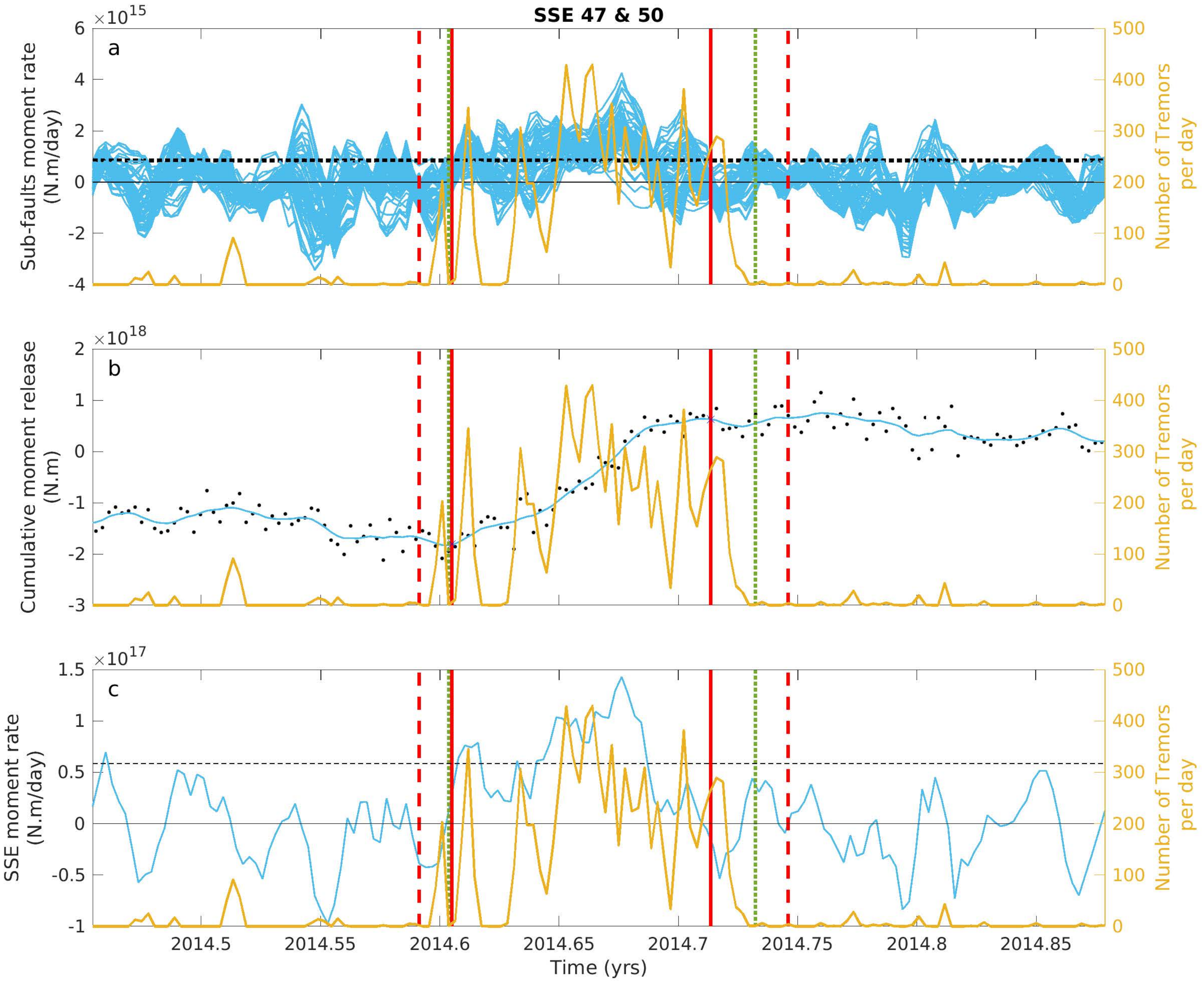


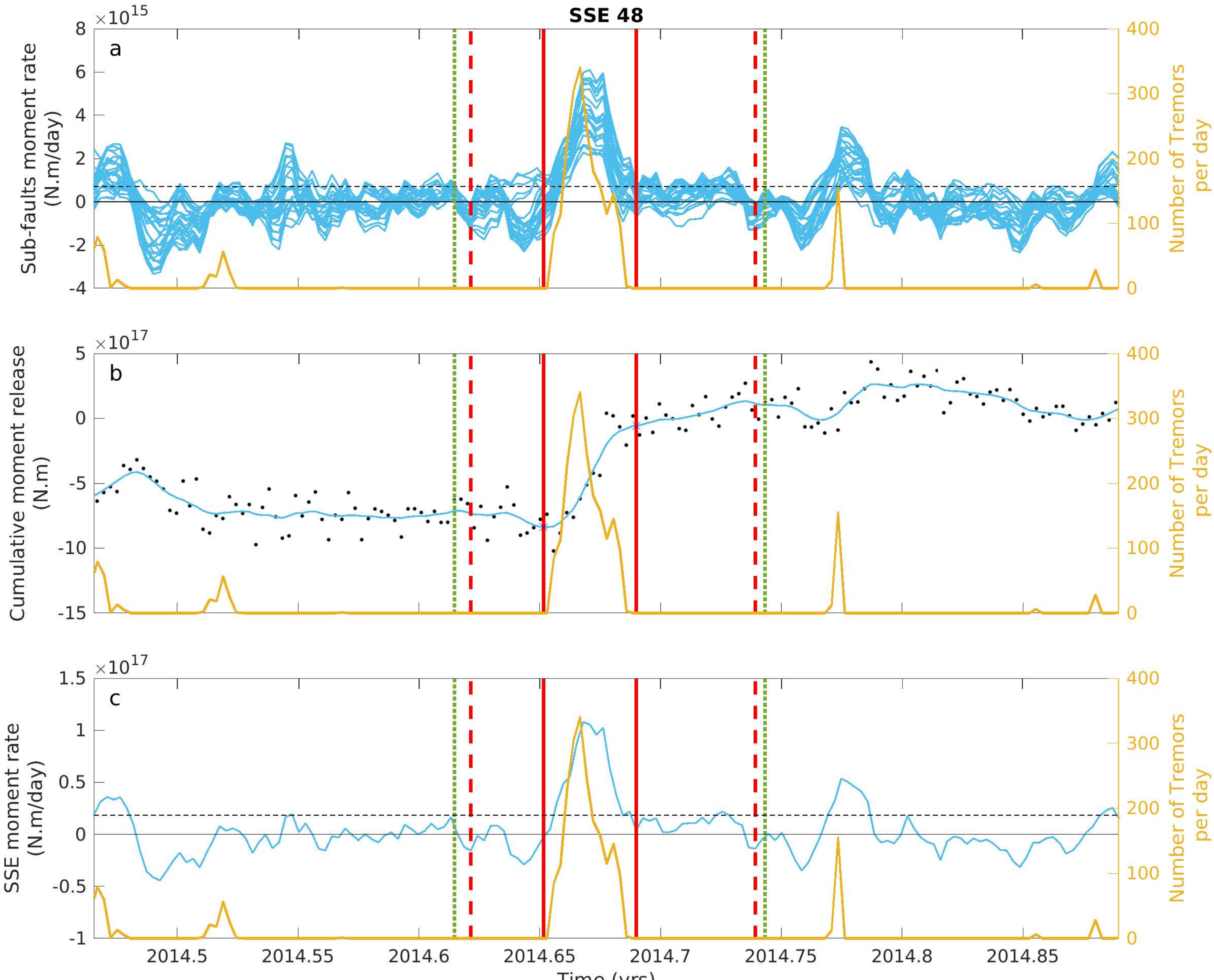
SSE 43
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)

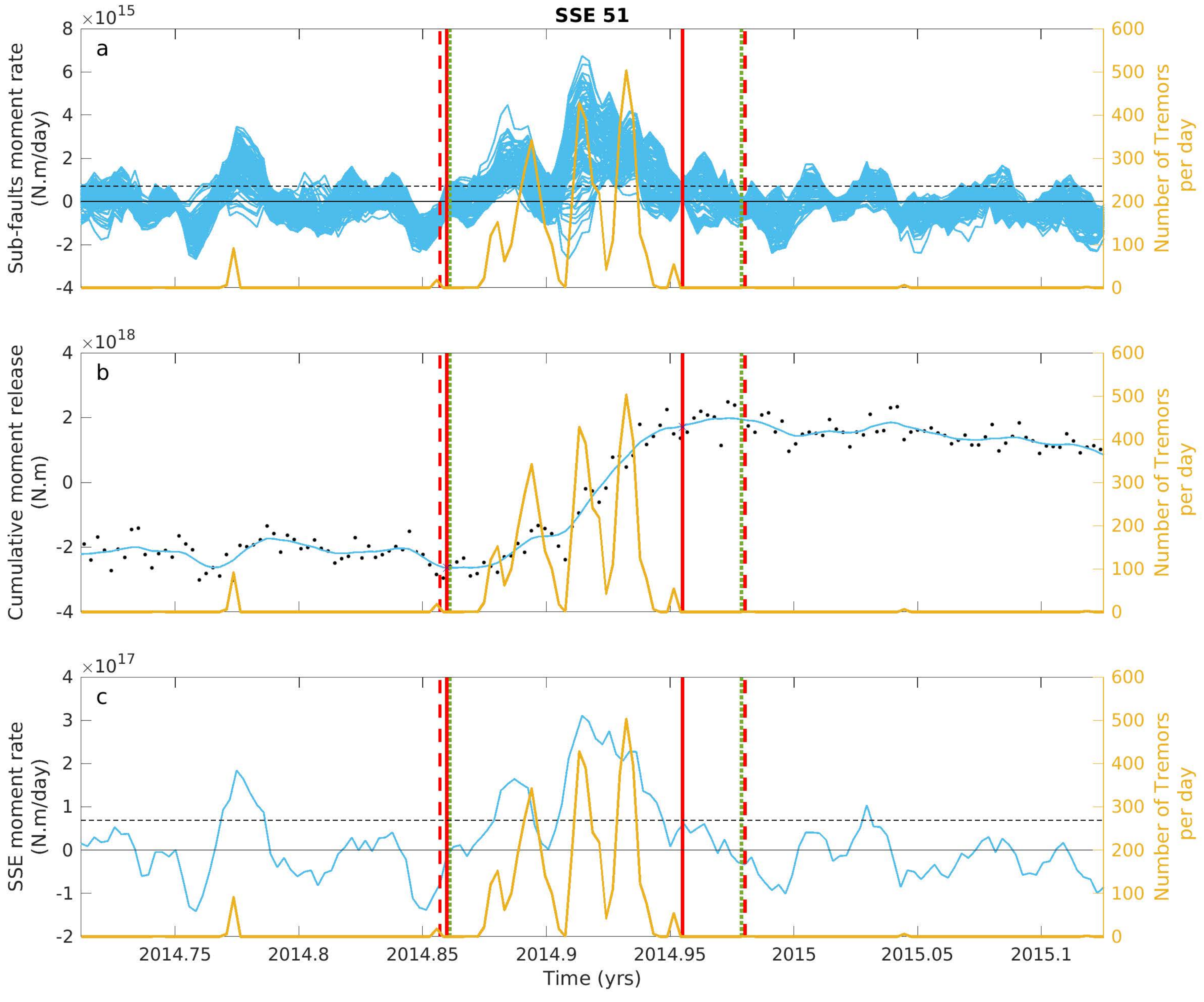

SSE 44
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
2014
2014.05
2014.1
2014.15
2014.2
2014.25
2014.3



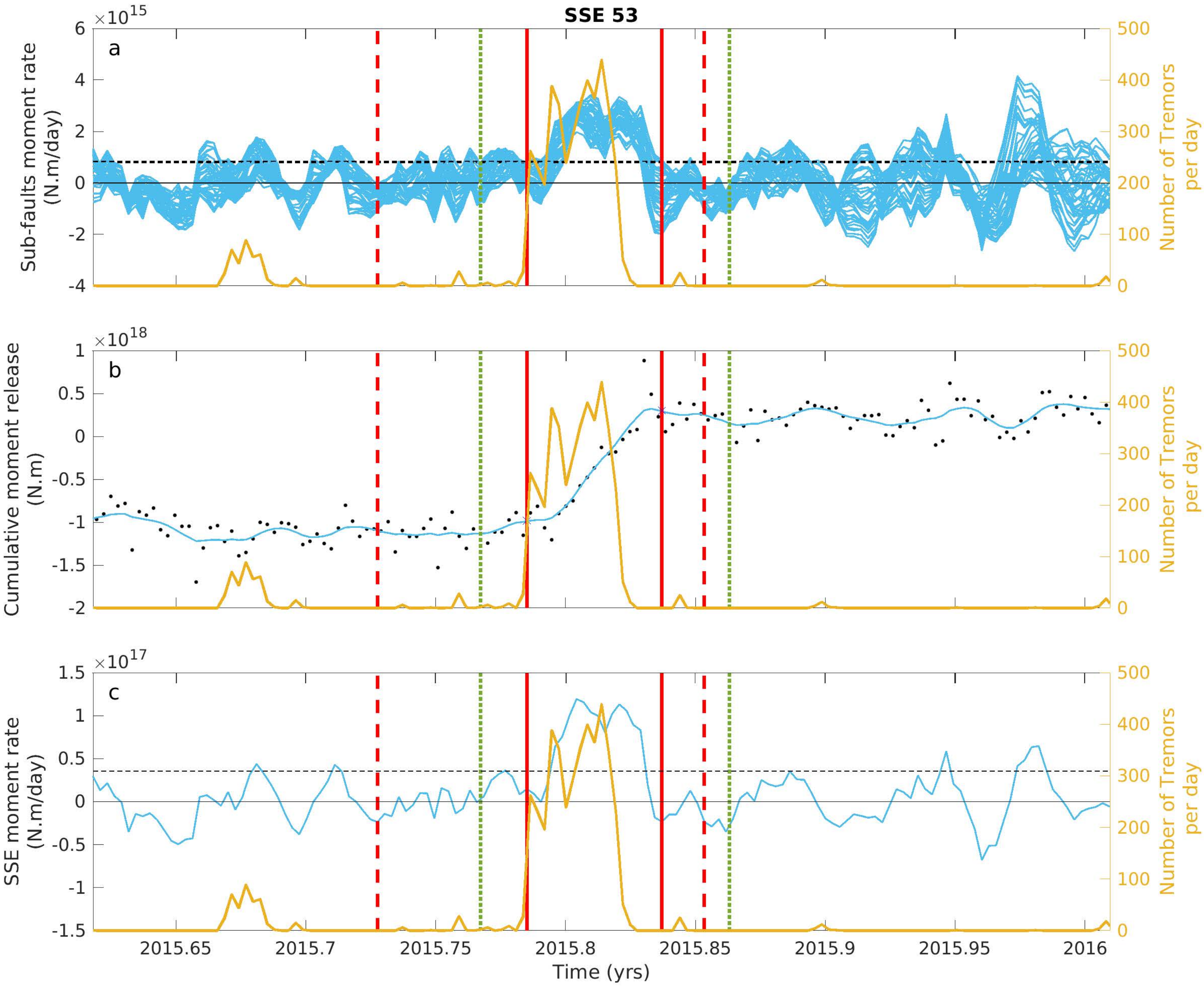
SSE 45 & 46
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
$\times 10^{15}$
$\times 10^{17}$
$\times 10^{16}$
Time (yrs)
2014.25
2014.3
2014.35
2014.4
2014.45
2014.5
2014.55
2014.6
2014.65

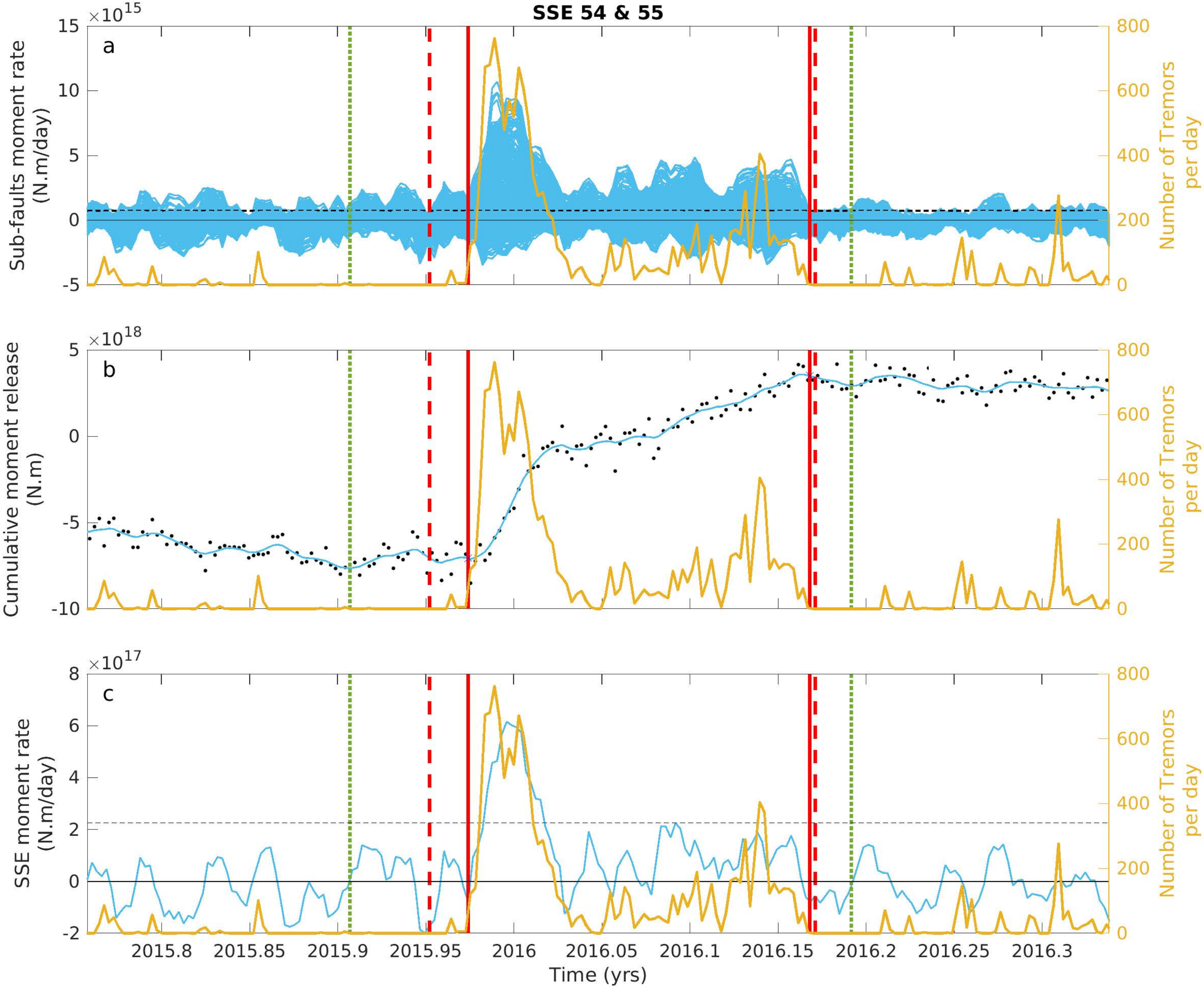

SSE 47 & 50
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^18
×10^17
Time (yrs)
2014.5
2014.55
2014.6
2014.65
2014.7
2014.75
2014.8
2014.85


SSE 48
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^17
×10^17
Time (yrs)
2014.5
2014.55
2014.6
2014.65
2014.7
2014.75
2014.8
2014.85

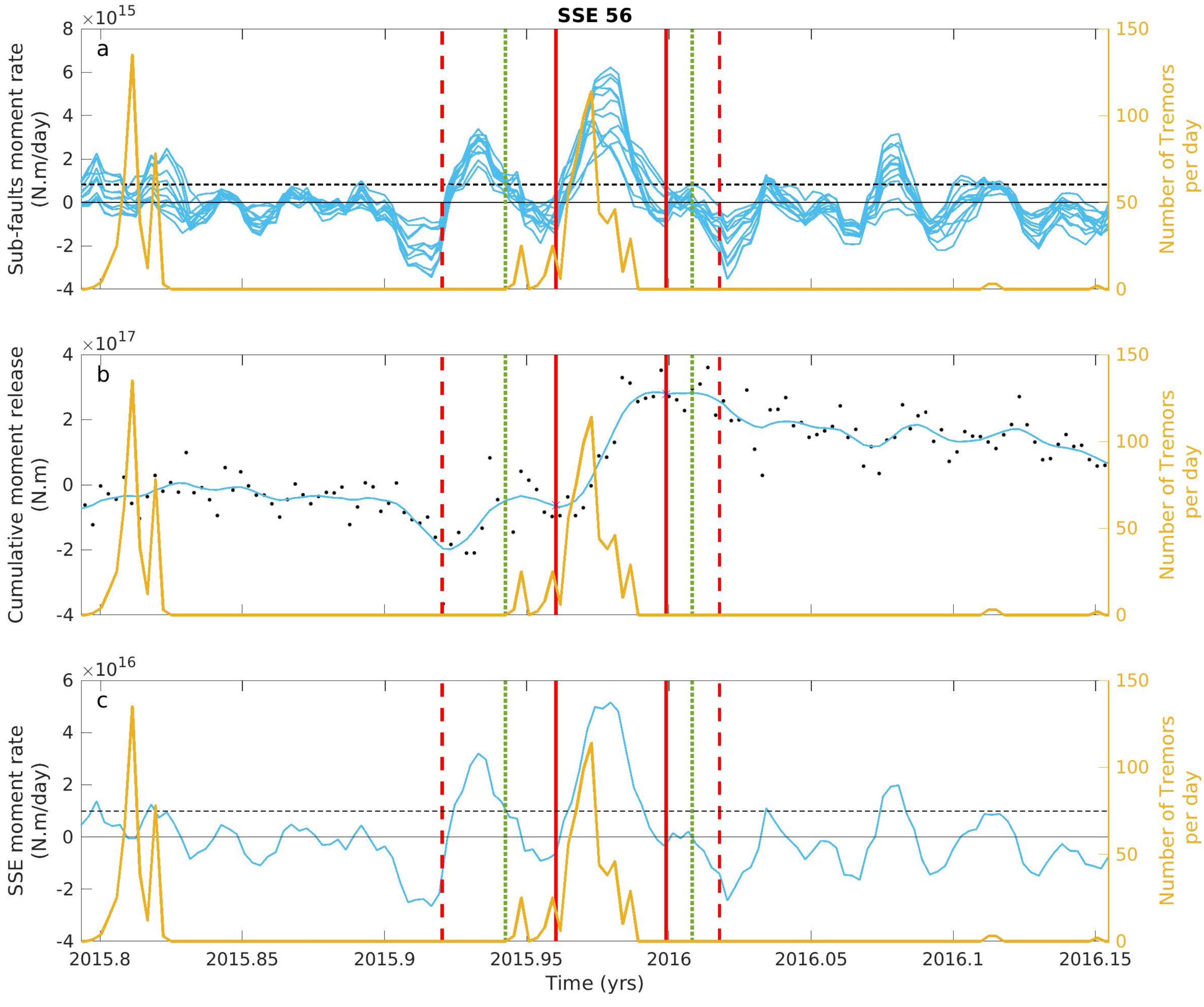


SSE 51
a
b
c
×10^15
×10^18
×10^17
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
2014.75
2014.8
2014.85
2014.9
2014.95
2015
2015.05
2015.1

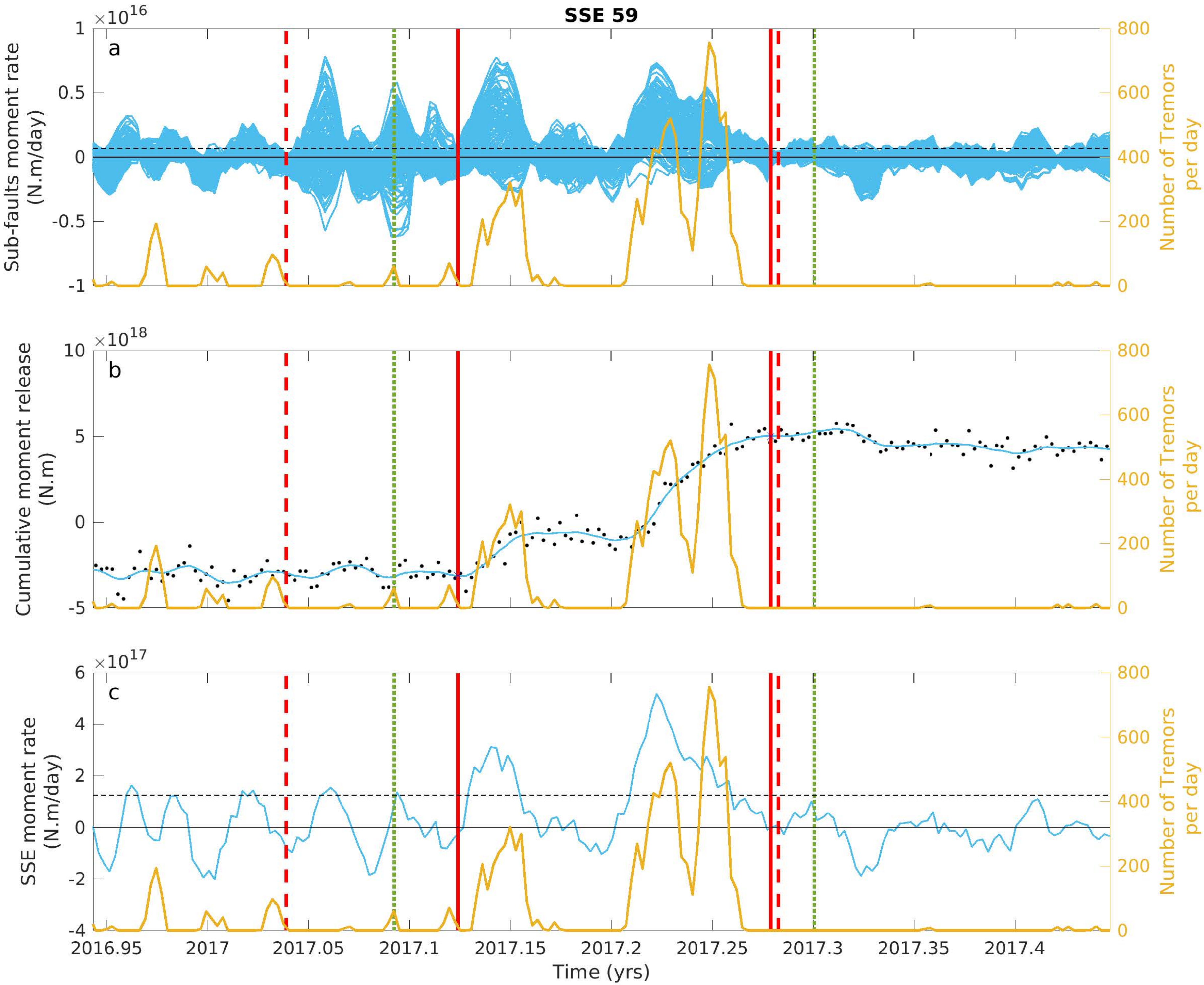

SSE 53
a
b
c
×10^15
×10^18
×10^17
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)
2015.65
2015.7
2015.75
2015.8
2015.85
2015.9
2015.95
2016

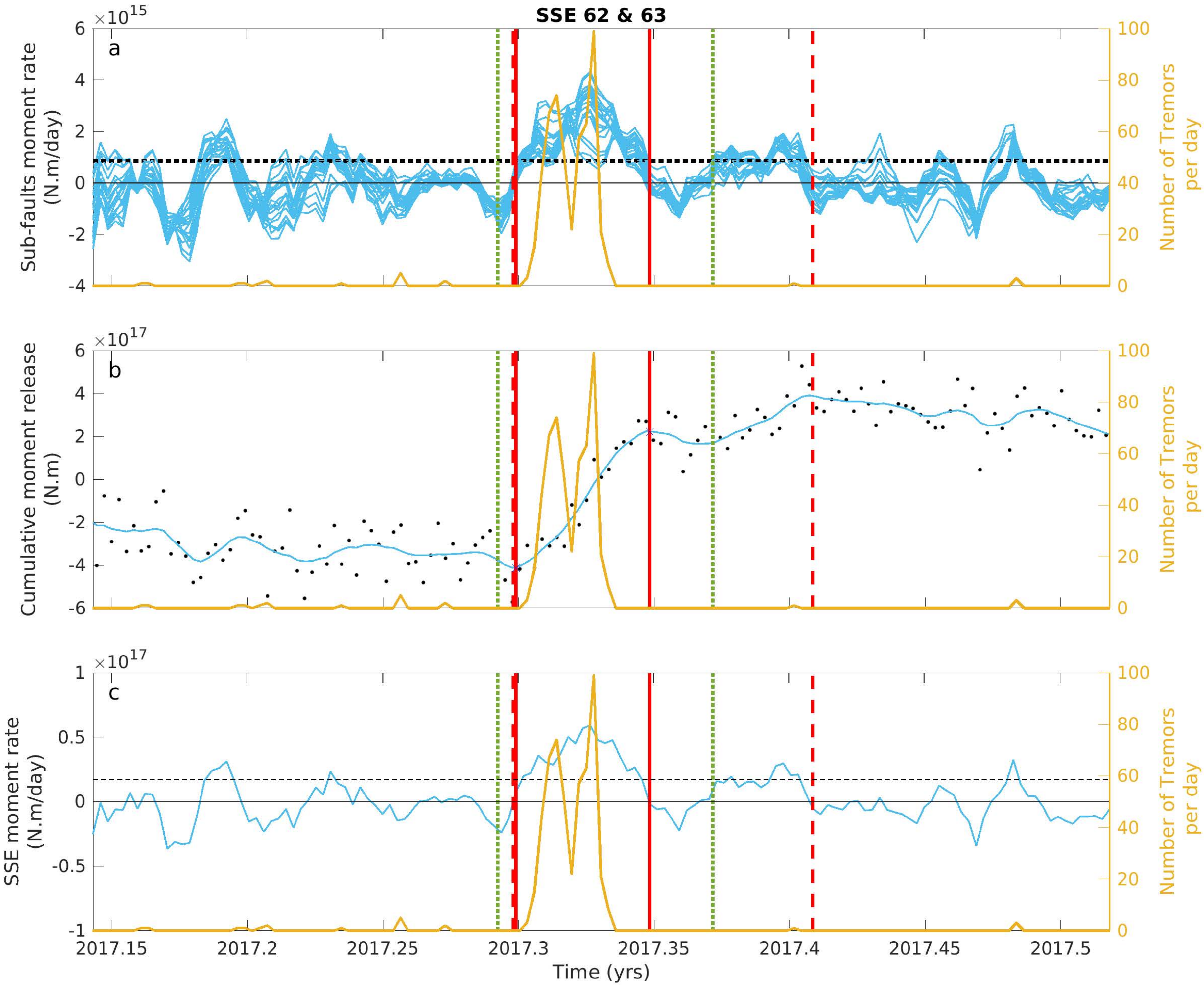


SSE 54 & 55
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
Time (yrs)

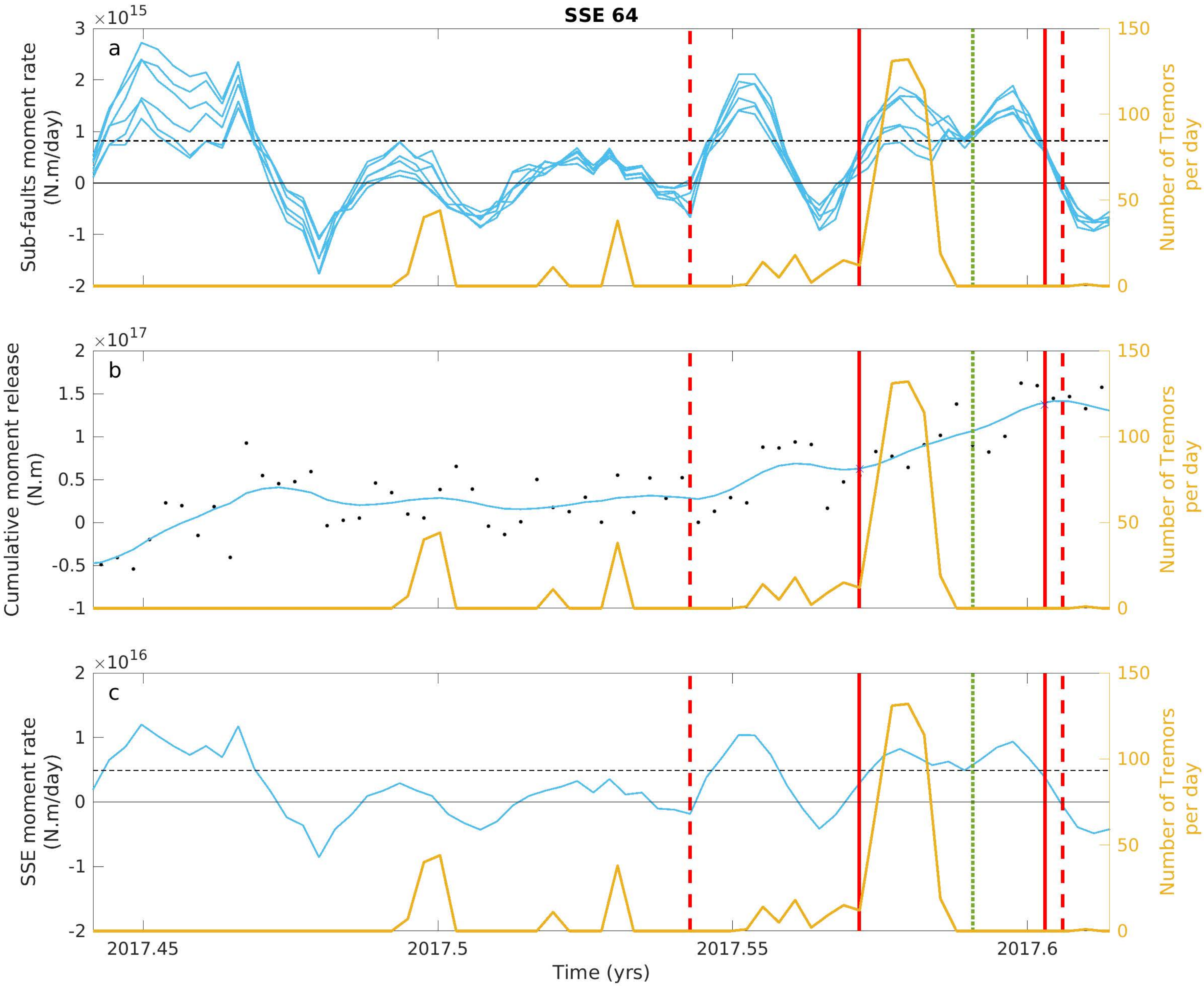


SSE 56
a
b
c
×10^15
×10^17
×10^16
Sub-faults moment rate
(N.m/day)
Cumulative moment release
(N.m)
SSE moment rate
(N.m/day)
Number of Tremors
per day
Time (yrs)
2015.8
2015.85
2015.9
2015.95
2016
2016.05
2016.1
2016.15


SSE 59
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^16
×10^18
×10^17
Time (yrs)
2016.95
2017
2017.05
2017.1
2017.15
2017.2
2017.25
2017.3
2017.35
2017.4



SSE 62 & 63
×10^15
a
Sub-faults moment rate
(N.m/day)
Number of Tremors
per day
×10^17
b
Cumulative moment release
(N.m)
×10^17
c
SSE moment rate
(N.m/day)
2017.15
2017.2
2017.25
2017.3
2017.35
2017.4
2017.45
2017.5
Time (yrs)


SSE 64
a
b
c
Sub-faults moment rate (N.m/day)
Cumulative moment release (N.m)
SSE moment rate (N.m/day)
Number of Tremors per day
×10^15
×10^17
×10^16
Time (yrs)
2017.45
2017.5
2017.55
2017.6

SSE 3

- General Comment: This event coincides with a continuous tremor burst. The envelope of the sub-faults moment rate curves shown in (a) doesn't cross 0 N.m/day due to simultaneous loading and unloading of different sub-faults as the event is propagating. The picking of the SSE onset and end times are thus also based on the cumulated moment release (b). The SSE is mainly composed of 2 large peaks of sub-faults moment rates (a) followed by a tail of moderate to low moment rate release.
- Start Max : picked when the envelope of the sub-fault moment rate curves (a) approaches 0 N.m/day, before the 1st peak of sub-faults moment rate.
- Start Min : picked when the first sub-fault moment rate curve (a) crosses $M_{0\ thresh}$ N.m/day, before the 1st peak of sub-faults moment rate.
- End Min : picked when the sub-faults moment rates envelope (a) approaches $M_{0\ thresh}$ N.m/day, after the 2nd peak and tail of sub-faults moment rate.
- End Max : picked when the envelope of the sub-faults moment rate curves (a) approaches 0 N.m/day, after the 2nd peak and tail of sub-faults moment rate.

SSE 4

- General Comment: This is a small event. The sub-faults moment rate functions shows 1 to 3 peaks (a). The estimated minimum duration takes only into account the 2nd peak. The estimated maximum duration takes all three peaks into account. The cumulated moment release during that SSE (b) increases at almost a constant rate. The duration is poorly constrained in this case.
- Start Max : picked when the envelope of the sub-faults moment rate functions (a) approaches 0 N.m/day, before the 1st peak of sub-faults moment rates. There are no tremors clearly associated to this event.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 2nd peak of sub-faults moment rate.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 3rd peak of sub-faults moment rate.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 3rd peak of moment rate.

SSE 5 & 6

- General Comment: After inspection of the spatio-temporal evolution of these SSEs, we decided to combine these two events into one single SSE. The envelope of the sub-faults moment rate curves (a) doesn't cross 0 N.m/day due to simultaneous loading and unloading of different sub-faults as the event is propagating. The picking of the SSE onset and end times are thus also based on the cumulated moment release (b). The moment rate curves show 2 peaks (a&b). This event, is close in time and space to SSE 7 and 8.
- Start Max : picked when the sub-faults moment rates (a) approach 0 N.m/day, before the 1st peak of moment rate.
- Start Min : picked when the sub-faults moment rate curves (a) cross $M_{0\ thresh}$ N.m/day, before the 1st peak of moment rate.

- End Min : picked when the sub-faults moment rates (a) cross $M_{0\ thresh}$N.m/day, after the 2nd peak of moment rate. It coincide with the end of the tremors burst.
- End Max : picked when the sub-faults moment rates (a) approach for the only time 0 N.m/day, after the 2nd peak of moment rate.

SSE 7

- General Comment: This SSE has 2 peaks of moment rate release (a). The estimated minimum duration takes only into account the 1st peak. The estimated maximum duration takes both peaks into account.
- Start Max : picked when the sub-faults moment rates (a) cross 0 N.m/day, before the 1st peak of moment rates.
- Start Min : picked when the sub-faults moment rates (a) cross $M_{0\ thresh}$ N.m/day, before the 1st peak of moment rates.
- End Min : picked when the sub-faults moment rates (a) cross $M_{0\ thresh}$ N.m/day, after the 1st peak of moment rates. It coincide with the end of the tremor burst.
- End Max : picked when the sub-faults moment rates (a) cross 0 N.m/day, after the 2nd peak of moment rates.

SSE 8

- General Comment: This SSE has 2 peaks of moment rate release (a) followed by a plateau at noise level. The estimated minimum duration takes only into account the 2nd peak. The estimated maximum duration takes also the 1st peak and the plateau into account.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st peak of moment rates.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 2nd peak of moment rates.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 2nd peak of moment rates.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the small plateau of moment rates.

SSE 9

- General Comment: This SSE has 4 peaks of sub-faults moment rates (a) slightly above the noise level. The estimated minimum duration takes only into account the 2nd peak. The estimated maximum duration takes all the peaks into account since the cumulated moment release (b) increases during the 4 peaks.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st peak of moment rates.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 2nd peak of moment rates.

- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 2nd peak of moment rates.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 4th peak of moment rates.

SSE 10

- General Comment: This event coincides with a continuous tremor burst The envelope of the sub-faults moment rate curves (a) doesn't cross 0 N.m/day due to simultaneous loading and unloading of different sub-faults as the event is propagating. The picking of the SSE onset and end times are thus also based on the cumulated moment release (b). The SSE is mainly composed of 3 large peaks of sub-faults moment rates (a).
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the main peak of moment rates.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the main peak of moment rates.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the last large peak of moment rates.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after the continuous high moment rates.

SSE 12

- General Comment: This event has a main peak of sub-faults moment rates (a) surrounded by plateaus near noise level. The 2nd plateau is taken into account, even if all of the sub-faults moment rates cross 0 N.m/day before, because of its role in the significant increase of cumulated moment release (b). The estimated minimum duration takes only into account the peak. The estimated maximum duration takes the plateaus into account.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st plateau of moment rates.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the peak of moment rates.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the peak of moment rates.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 2nd plateau.

SSE 13

- General Comment: This SSE has 3 main peaks of sub-faults moment rates (a). The estimated minimum duration takes only into account the 2nd peak. The estimated maximum duration takes the 3 peaks into account, which are associated with an increase of cumulated moment release (b).

- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st peak of moment rates.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 2nd peak of moment rates.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 2nd peak of moment rates.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 3rd peak of moment rates.

SSE 14

- General Comment: This SSE has one small peak of sub-faults moment rates (a) surrounded by plateaus near noise level. The burst of tremor seems to be coincident with the 2nd plateau.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st plateau of moment rates.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the main peak of moment rates.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 2nd plateau. It coincide with the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 2nd plateau.

SSE 15

- General Comment: This SSE has one main peak of sub-faults moment rates (a) followed by a smaller peak near noise level which increases the cumulated moment release (b) to its maximum.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the main peak of moment rates.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the main peak of moment rates.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the main peak of moment rates.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after the small peak of moment rates which increase slightly more the cumulated moment release during that SSE (b).

SSE 16

- General Comment: This event coincides with a continuous tremor burst. The sub-faults moment rates envelope (a) never cross 0 N.m/day due to the presence of sub-faults with opposite moment rate behaviour (loading/unloading relative to the long term moment rate), within the SSE, made possible by the along strike propagation of the event. The decision of the start and end time is thus also based on the cumulated moment release.

- Start Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, before the high moment rates.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the high moment rates. It coincides with the beginning of the tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the high moment rates. It coincides with the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after the high moment rates.

SSE 18

- General Comment: This SSE has first a plateau of sub-faults moment rates near noise level followed then by 3 peaks (a). The estimated minimum duration takes only into account the 2 first peaks, which coincides with a tremor burst. The estimated maximum duration takes the other peak and the plateau into account associated with a significant increase of the cumulated moment release (b).
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the plateau.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 1st peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 2nd peak. It coincides with the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 3rd peak.

SSE 19

- General Comment: This event coincides with a continuous tremor burst. The envelope of the sub-faults moment rate curves (a) doesn’t cross 0 N.m/day due to simultaneous loading and unloading of different sub-faults as the event is propagating. The picking of the SSE onset and end times are thus also based on the cumulated moment release (b).
- Start Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, before the largest peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the largest peak. It coincides with the beginning of the tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after continuous large moment rate. It coincides with the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after continuous large moment rate.

SSE 22 & 23

- General Comment: Looking at the SSEs spatio-temporal evolution, we decided to combine those two events into one. This is a small SSE with 3 peaks of sub-faults moment rates (a). The estimated minimum duration takes only into account the 2nd peak, which coincides with the tremor burst. The estimated maximum duration takes the other peaks into account, which are associated with a significant cumulated moment release (b).

- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 2nd peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 2nd peak. It ends slightly before the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 3rd peak.

SSE 24

- General Comment: This SSE coincides with a continuous tremor burst. The sub-faults moment rates (a) never cross 0 N.m/day due to the presence of sub-faults with opposite moment rate behaviour (loading/unloading relative to the long term moment rate), within the SSE, made possible by the along strike propagation of the event. The decision of the SSE start and end time is thus also based on the cumulated moment release (b).
- Start Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, before the largest peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the largest peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after most of the largest peaks. It ends slightly after the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after one small peak that coincides with the beginning of a decrease of the cumulated moment release (b).

SSE 26

- General Comment: This SSE has 3 large sub-faults moment rates peaks (a). None of the large peaks coincides clearly with the present tremor burst. The estimated minimum duration takes only into account the largest peak, the closest to the tremor burst. The estimated maximum duration takes the other peaks into account associated with a moderate increase of cumulative moment release (b).
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st peak. It coincides with the beginning of moderate increase of cumulative moment release (b).
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just before the largest peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the large peak. It actually cuts the tremor burst in the middle.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the largest peak.

SSE 27

- General Comment: This SSE has 1 large sub-faults moment rates peak (a) surrounded by near noise moment rate minor peaks. Only the large peak coincide with a tremor burst. The estimated minimum duration takes only into account the large peak. The estimated maximum duration takes the other minor peaks into account, which are associated with a significant increase of cumulated moment release (b).
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the first minor peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just before the large peak. It coincides with the start of the tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the large peak. It coincides with the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after several minor peaks, which are associated with a significant increase of cumulated moment release (b).

SSE 28

- General Comment: This SSE has 2 large sub-faults moment rates peaks (a) surrounded by near noise moment rate plateaus. Only the large peaks coincide with a tremor burst. The estimated minimum duration takes only into account the large peaks. The estimated maximum duration takes the plateaus into account, which are associated with a significant increase of cumulated moment release (b).
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the plateau. It coincides with the beginning of a weak increase of cumulated moment release (b).
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just before the 1st large peak. It coincides with the start of the tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 2nd large peak. It coincides with the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after the plateau which coincides with moderate increase of cumulated moment release (b).

SSE 29

- General Comment: This SSE has a sub-faults moment rates peaks (a) surrounded by near noise moment rate peaks. Only the one of the small peaks coincide with a tremor burst. The estimated minimum duration takes only into account the largest peak. The estimated maximum duration takes the other peaks into account, which are associated with a significant increase of cumulated moment release (b).
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 2 small peaks preceding the large peak. It coincides with the beginning of significant increase of cumulated moment release (b).

- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just before the large peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the large peak.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the last small peak. It coincides with the end of a moderate increase of cumulated moment release (b).

SSE 30

- General Comment: This SSE coincides with a continuous tremor burst. The sub-faults moment rates (a) never cross 0 N.m/day due to the presence of sub-faults with opposite moment rate behaviour (loading/unloading relative to the long term moment rate), within the SSE, made possible by the along strike propagation of the event. The decision of the SSE start and end time are thus also based on the cumulated moment release (b).
- Start Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day. It coincides with the start of the tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day. It coincides with the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after a small bump in the sub-faults moment rates (a), when the cumulated moment release (b) begins to decrease.

SSE 33

- General Comment: This SSE has 4 sub-faults moment rates peaks (a). Only the 3rd large peak coincide with a tremor burst. The estimated minimum duration takes only into account the 3rd large peak. The estimated maximum duration takes the other peaks into account, which are associated with significant increase in cumulated moment release (b).
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st large peak. It coincides with a significant increase in cumulated moment release (b).
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just before the 3rd large peak. It coincides with the start of the tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 3rd large peak. It coincides with the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 4th major peak.

SSE 34

- General Comment: This SSE has 2 large sub-faults moment rates peaks and other minor peaks that approach the noise level (a). Only the two large peaks coincide with a tremor burst. The sub-faults moment rates (a) never cross 0 N.m/day due to the presence of sub-faults with opposite moment rate behaviour (loading/unloading relative to the long term moment rate), within the SSE, made possible by the along strike propagation of the event. The decision of the SSE start and end picking is thus also based on the cumulated moment release (b). The estimated minimum duration takes only into account the 2 large peaks. The estimated maximum duration takes the other minor peaks before the large peaks into account, which are associated with a significant increase in the cumulated moment release (b).

- Start Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, before the major and minor peaks. It coincides with the beginning of the significant increase in the cumulated moment release (b).
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just before the 1st major peak. It coincides with the start of the tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 2nd major peak. It coincides with the end of the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 2nd major peak.

SSE 36

- General Comment: This SSE has 2 large sub-faults moment rates peak (a). Only the first one coincide with a tremor burst. The estimated minimum duration takes only into account the 1st peak. The estimated maximum duration takes both peaks into account.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st major peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 1st major peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 1st major peak.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, the 2nd major peak.

SSE 37

- General Comment: This SSE has 2 large sub-faults moment rates peak (a). Only the second one coincide with a continuous tremor burst. The estimated minimum duration takes only into account the 2nd peak. The estimated maximum duration takes both peaks into account.
- Start Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, before the 1st major peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 2nd major peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 2nd major peak.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, the 2nd major peak.

SSE 38 & 39

- General Comment: Looking at the SSEs spatio-temporal evolution, we decided to combine those two events into one. This SSE has 4 main peaks of sub-faults moment rates (~2013.19, 2013.23, 2013.28 and 2013.335) that coincides with tremor bursts (a). Another tremor burst is present before them (~2013.17) but is not associated with large sub-faults moment rate. Note that the SSE englobes 3 large tremor clusters which are not continuous in space and time in terms of propagation. We assume that the 3 peaks of sub-faults moment rates associated with the 3 big tremor clusters defines one SSE (excluding the 1st tremor burst in a). The sub-faults moment rates (a) never cross 0 N.m/day due to the presence of sub-faults with opposite moment rate behaviour (loading/unloading relative to the long term moment rate), within the SSE, made possible by the along strike propagation of the event. The decision of the SSE start and end time is thus also based on the cumulated moment release.
- Start Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, before the noise level plateau preceding the 1st major peak .
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 1st major peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 3rd major peak.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after the 4th major peak.

SSE 40

- General Comment: This SSE is composed of 4 even peaks of sub-faults moment rates. None of those peaks coincide clearly with a tremor burst. The estimated minimum duration takes only into account the 2nd peak, which is the closest to the tremor burst. The estimated maximum duration takes all the peaks into account.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the peak closest to the tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the peak closest to the tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the last peak.

SSE 41

- General Comment: This SSE coincides with a continuous tremor burst. The sub-faults moment rates (a) never cross 0 N.m/day due to the presence of sub-faults with opposite moment rate behaviour (loading/unloading relative to the long term moment rate), within the SSE, made possible by the along strike propagation of the event. The decision of the SSE start and end time is thus also based on the cumulated moment release. The SSE is composed of 3 peaks of sub-faults moment rates (a).

- Start Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, before the 1st major peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 1st major peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 3rd major peak.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, the 3rd major peak.

SSE 43

- General Comment: This SSE is composed of 3 peaks and a plateau of sub-faults moment rates. There are 2 tremor bursts, of which one coincides with a peak of sub-faults moment rates. The estimated minimum duration takes only into account the 3rd peak and the plateau, the peak being the one coinciding with the tremor burst. The estimated maximum duration takes all the peaks and the plateau into account.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 3rd peak which is coinciding with to the tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the plateau.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after the plateau.

SSE 44

- General Comment: This SSE is composed of a 2 peaks of sub-faults moment rates. No tremor burst coincide clearly with a peak of sub-faults moment rates. The estimated minimum duration takes only into account the 1st broad peak. The estimated maximum duration takes both peaks into account.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 1st peak which is coinciding with to the tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 1st peak.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 2nd peak.

SSE 45 & 46

- General Comment: Looking at the SSEs spatio-temporal evolution, we decided to combine those two events into one. The SSE includes a plateau of sub-faults moment rates (a), before 3 peaks of moment rate. The estimated minimum duration englobes the last 2 peaks that are significantly over $M_{0\ thresh}$ N.m/day and is englobed in a tremor burst. The maximum duration includes additionally the plateau and is surely a big overestimation of the duration.

- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the plateau.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 2nd major peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 3rd major peak.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 3rd major peak.

SSE 47 & 50

- General Comment: Looking at the SSEs spatio-temporal evolution, we decided to combine those two events into one. This SSE coincides with a continuous tremor burst. The sub-faults moment rates (a) never cross 0 N.m/day due to the presence of sub-faults with opposite moment rate behaviour (loading/unloading relative to the long term moment rate), within the SSE, made possible by the along strike propagation of the event. The decision of the SSE start and end time is thus also based on the cumulated moment release (b). Note that the first 2 isolated peaks of tremor burst (~2014.6), just before the main tremor burst, are not really part of the continuous propagating tremor burst. They are however located at the same latitude.
- Start Max : picked when the sub-faults moment rates (a), except one, approach 0 N.m/day.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day after the end of the tremor burst.

SSE 48

- General Comment: The SSE is composed of a major peak of sub-faults moment rates surrounded by moderate plateaus (a). The 2 plateaus are at the $M_{0\ thresh}$ level. The first plateau of moderate sub-faults moment rates has actually only very few sub-faults that reaches $M_{0\ thresh}$. We thus decide, even though the sub-faults moment rates (a) don't cross $M_{0\ thresh}$ N.m/day, to pick the minimum duration close to the major moment rate peak. The major moment rate peak actually englobes a tremor burst.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st moment rate plateau.
- Start Min : picked when the majority of sub-faults moment rates (a) cross $M_{0\ thresh}$ N.m/day, just before the major peak.
- End Min : picked when the sub-faults moment rates envelope (a) approaches $M_{0\ thresh}$ N.m/day, just after the major peak.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 2nd moment rate plateau.

SSE 51

- General Comment: The SSE includes 2 peaks of sub-faults moment rates which coincide also with 2 tremor bursts. Note that the 1st tremor burst starts outside our SSE area, as estimated by our method, and propagates within. However, we assume here that it is a single SSE and try not to divide the event in two or enlarge the SSE area to englobe the start of the tremor burst.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st major peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 1st major peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the 2nd major peak.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after the 2nd major peak and a small bump of sub-faults moment rate.

SSE 53

- General Comment: The SSE is composed of 1 peak of sub-faults moment rates preceded by plateaus near noise level (a). The estimated minimum duration takes only into account the peak. The estimated maximum duration takes the plateau into account.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the plateau at noise level.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just before the peak. It coincides perfectly with the beginning of the tremor burst
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just after the peak.
- End Max : picked when the sub-faults moment rates envelope (a) cross 0 N.m/day, after the peak.

SSE 54 and 55

- General Comment: Looking at the SSEs spatio-temporal evolution, we decided to combine those two events into one. This SSE coincides with a continuous tremor burst. It is divided into 2 phases: a phase of large moment release and a phase of moderate moment release. The sub-faults moment rates (a) never cross 0 N.m/day due to the presence of sub-faults with opposite moment rate behaviour (loading/unloading relative to the long term moment rate), within the SSE, made possible by the along strike propagation of the event. The decision of the SSE start and end time is thus also based on the cumulated moment release (b).
- Start Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day before the largest peak of moment rate and the tremor burst. It includes a small bump of moment rate before the largest peak and coincides with a smooth beginning of an increase in cumulated moment release (b). However, it is unclear if this small bump of moment rate is real since it is within the noise level.

- Start Min : picked when the sub-faults moment rates increase to its largest peak (a). It does not include the small bump before but coincide perfectly with the beginning of the tremor. Note that it does not reach $M_{0\ thresh}$ but that the cumulated moment release is almost stable.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after a succession of large peaks of moment rate. It is located just after the tremor burst.
- End Max : It is picked very close to End Min since the sub-faults moment rates envelope keeps oscillating around $M_{0\ thresh}$ after this date.

SSE 56

- General Comment: This SSE is composed of 2 peaks of sub-faults moment rate (a). The 2nd peak coincide with a tremor burst. The estimated minimum duration takes only the 2nd peak into account. The estimated maximum duration takes both peaks into account.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day before the 1st peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day just before the 2nd peak. It is located just before the first tremor burst. Note that the first little peak of tremor burst (~2015.95) is dissociated in space from the main tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just after the 2nd peak. It is located just after the 2nd tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the 2nd peak. It coincide with the start of the decrease of cumulated moment release.

SSE 59

- General Comment: This SSE is composed of 5 peaks of sub-faults moment rates (a). Two of those peaks are dominant and coincide with tremor bursts (a). The other 3 peaks of moment rate don't contribute too much increase of the cumulated moment release (b). The estimated minimum duration takes only the two peaks associated with tremor bursts into account. The estimated maximum duration takes the other peaks into account.
- Start Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day before several large peaks of moment rate.
- Start Min : picked when the sub-faults moment rates envelope (a) approaches $M_{0\ thresh}$ N.m/day before the 1st peak of moment rate associated with first tremor burst.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just after the peak of moment rate associated with the 2nd tremor burst.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after the last peak of moment rate associated with the 2nd tremor burst. The cumulated moment release (b) seems stable thereon.

SSE 62 and 63

- General Comment: Looking at the SSEs spatio-temporal evolution, we decided to combine those two events into one. This SSE is composed of 1 main peak of sub-faults moment rate (a) followed by a smaller one. The 1st peak coincide with a tremor burst. The estimated minimum duration takes only the 1st peak into account. The estimated maximum duration takes both peaks into account.

- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, just before the largest peak of moment rate.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just before the largest peak of moment rate.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, just after the largest peak of moment rate.
- End Max : picked when the sub-faults moment rates envelope (a) approaches 0 N.m/day, after the 2nd peak of moment rate (2014.4086). It does not reach 0 N.m/day but it coincides with a steady decrease of cumulated moment release (b).

SSE 64

- General Comment: This SSE is small and is composed of a 3 peaks of sub-faults moment rates. The tremor burst coincide with the 2nd peak of sub-faults moment rates. The estimated minimum duration takes only into account the 1st and 2nd peak. The estimated maximum duration takes the 3 peaks into account.
- Start Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, before the 1st peak.
- Start Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, before the 2nd peak.
- End Min : picked when the sub-faults moment rates envelope (a) crosses $M_{0\ thresh}$ N.m/day, after the last peak.
- End Max : picked when the sub-faults moment rates envelope (a) crosses 0 N.m/day, after the last peak.